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PHARMACY

THEORETICAL AND PRACTICAL

INCLUDING

ARITHMETIC OF PHARMACY

BY

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PREFACE

The object of this book is to present in as few words as possible essential facts which every pharmacist should know. The writer believes that every student of pharmacy should possess copies of the Pharmacopœia and National Formulary and use them as text books; that only in this way will he come to have the proper appreciation of these authorities. Having these books at hand, there is no need of repeating in a text book on Pharmacy what is given in them. The comments herein given on preparations will be intelligible to those who have before them copies of the U. S. P. and N. F.

Cuts of apparatus are intentionally omitted. It is expected that this book will be used by students in college where the actual apparatus will be shown by the instructor, or that it will be used by persons working in stores where they will find the more common pieces of apparatus.

E. A. Ruddiman.

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PHARMACY

ARITHMETIC OF PHARMACY

METROLOGY

Definitions. Metrology treats of the measure of length, surface, volume, and weight, and of the relation of one to another. **Volume** is the amount of space which a body occupies. **Weight** is the measure of the force with which the earth draws other bodies to its center. **Density** refers to the weight of a body compared with its volume. **Specific gravity** is the weight of a body compared with the weight of an equal volume of some substance taken as the standard.

COMMON SYSTEM

The systems of weights and measures used in the United States are avoirdupois, troy, apothecary, wine, and metric. The avoirdupois weight is used in all commercial transactions where weight is wanted, except in weighing precious stones and in filling prescriptions. Drugs in bulk are bought and sold by the avoirdupois weight even though the bulk is small. An eighth of an ounce of atropine is an eighth of 437.5 grains, not an eighth of 480 grains. This must be kept in mind in pricing prescriptions. Troy weight is used in weighing precious metals and stones. Apothecary weight is used only in filling prescriptions.

Apothecary or wine measure is used in measuring fluids. The Imperial measure is used in Great Britain and its provinces.

AVOIRDUPOIS WEIGHT

437.5 grains	= 1 ounce (oz.)
16 ounces	= 1 pound (lb.)

APOTHECARY WEIGHT

20 grains	= 1 scruple (℈)
3 scruples	= 1 dram (ʒ)
8 drams	= 1 ounce (℥)
12 ounces	= 1 pound (lb.)

APOTHECARY OR WINE MEASURE

60 minims (min.)	= 1 fluid dram (fl. ʒ)
8 fluid drams	= 1 fluid ounce (fl. ℥)
16 fluid ounces	= 1 pint (pt. or O.)
2 pints	= 1 quart (qt.)
4 quarts	= 1 gallon (gal. or Cong.)

IMPERIAL MEASURE

60 minims	= 1 fluid dram
8 fluid drams	= 1 fluid ounce
20 fluid ounces	= 1 pint
2 pints	= 1 quart
4 quarts	= 1 gallon

The grain in all systems is the same, so that by going back to it, one system can be converted into another. Attention is called to the variation in the pounds, and particularly to the variation in the ounces. In 1 lb. av. there are 7000 grains, and in 1 lb. apoth. there are 5760 grains. In 1 oz. av. there are 437.5 grains; 1 oz. apoth., 480 grains; 1 fl. oz. of water, wine measure, 456.3 grains at 4° C. or

455.7 grains at 15° C.; 1 fl. oz. of water, Imp. measure, 437.5 grains. One gallon contains 231 cubic inches or 58,329.6 grains of water at 15° C.

The equivalents of common household measures are given as follows: A drop is supposed to be a minim; a teaspoonful, a fluid dram or 4 mils; a dessertspoonful, two fluid drams, or 8 mils; a tablespoonful, four fluid drams, or 15 mils; a wineglassful, two fluid ounces; a teacupful, four fluid ounces; a tumblerful, eight fluid ounces. These domestic measures vary greatly. The drop may be from one-third to one and one-half minims, depending on viscosity, temperature, and the lip of the container from which dropped. A teaspoonful may be from one to two drams and a dessertspoonful from two to three drams. Graduated glasses should be used in the sick room for measuring medicines.

EXAMPLES

1. How many grains in 1 lb. av.?
2. How many grains in 1 lb. apoth.?
3. How many grains in 1 pt. of water?
4. How many apoth. ozs. in 1 lb. av.?
5. How many fl. ozs. in a gal.?
6. How many fl. ozs. in an Imp. gal.?
7. How many av. ozs. in 1 gal. of water at 4° C.?
8. How many av. ozs. in 1 gal. of water Imp. measure?
9. How many fl. drams in 1 pt.?
10. How many grains in 1 minim of water?
11. How many minims in 1 grain of water?
12. How many av. ozs. in 1 lb. apoth.?
13. Which is heavier, 1 lb. av. or 1 lb. apoth.?
14. Change 4 lbs. av. of water to wine measure.
15. What is the volume in fl. ozs. of 8 apoth. ozs. of water?
16. Reduce 3 qts. 2 pts. 5 ozs. to minims.
17. How many 2 gr. quinine capsules can be filled from a ⅛ oz. vial of quinine?

18. To make 24 pills, each to contain $\frac{1}{64}$ gr. strychnine sulphate and $\frac{1}{8}$ gr. iron phosphate, how many grains of each must be taken?

19. How many fl. ozs. of oil of turpentine will be required to fill 5 gross of 5 min. capsules?

20. If a gallon of a mixture contains 1 lb. 4 ozs. apoth. of a drug, how much drug in 1 fl. dram of the mixture?

21. How many grains of a remedy must be put into a 4 oz. prescription so that each dessertspoonful will contain $\frac{1}{2}$ gr.?

22. One gal. of elixir contains 1 lb. 9 ozs. 160 grs. of potassium bromide; how much bromide in 1 fl. oz. of the elixir?

23. How many doses in a $\frac{1}{8}$ oz. vial of atropine sulphate if the dose is $\frac{1}{75}$ gr.?

24. How many wine gals. in 1 Imp. gal.?

25. What is the cost of 10 bars of soap at 30 cents a pound, if each bar weighs 2 lbs. 3 ozs.?

26. What is the cost of 1 lb. of Dover's powder if opium costs $6.00 a lb., ipecac costs $1.50 a lb., and sugar of milk 55 cents a lb.?

27. Change 7 pts. wine measure to Imp. measure.

28. Change 3 pints of water to av. ozs.

29. How many doses of hyoscine of $\frac{1}{150}$ gr. each in $\frac{1}{4}$ gr.?

30. How many scruple doses in 2 ozs. of bismuth subnitrate?

31. If the dose of a remedy is $\frac{1}{200}$ gr., how many doses in $\frac{1}{32}$ gr.?

32. If the dose of a remedy is $\frac{1}{32}$ gr., how many doses in 4 grs.?

33. A prescription is to be taken in teaspoonful doses, and each dose is to contain 5 grains of potassium iodide; how many drams of iodide must be used in filling a 3 oz. prescription?

34. A prescription calls for 1 gr. of arsenic, 2 fl. drams of tinct. chloride of iron, 1.5 fl. drams of phosphoric acid, and elixir enough to make 4 fl. ozs., to be taken in teaspoonful doses; how much of each ingredient in one dose?

35. A prescription calls for 3 drams of fluidext. of buchu, 1 oz. of spirit nitrous ether, 5 drams of fluidext. of uva ursi, 2 drams of potassium acetate, 6 ozs. of syrup of tolu, to be taken in tablespoonful doses, three times a day; how long will the prescription last?

36. A prescription calls for $\frac{1}{2}$ oz. of a salt to be dispensed in a 6 fl. oz. solution, the dose of which is one dessertspoonful; how many grs. of salt are taken at a dose?

37. How much medicine will be required for three doses daily for two weeks, each dose being $\frac{1}{32}$ gr.?

38. What is the cost of twelve $\frac{1}{8}$ gr. powders of morphine sulphate, if 1 oz. costs $8.00?

39. What is the cost of 25 capsules, each containing 2 grs. of quinine, if quinine costs 90 cents an ounce, capsules cost 40 cents a thousand and the filling costs 10 cents?

40. What is the difference in wine minims between 1 pt. wine measure and 1 pt. Imp. measure?

Doses for Children

To calculate the dose for a child, take as numerator of a fraction the age, in years, of the child and as denominator the age plus 12, and take this fractional part of the adult dose.

41. What is the dose of santonin for a child 2 years old if the adult dose is 4 grs.?

42. What is the dose of Fowler's solution for a boy of 14 years, if the adult dose is 3 minims?

43. What is the dose for a child 5 years old, if the adult dose of atropine sulphate is $\frac{1}{75}$ gr.?

44. The adult dose of strychnine is $\frac{1}{48}$ gr.; what is the dose for a child $1\frac{1}{2}$ years old?

45. If the adult dose of calomel is 5 grains, what is the dose for a child 6 months old?

Metric System

The metric system is coming into use very slowly, although, being based on the decimal system, it is simpler than the common method. The starting point of the metric system is the meter, which is the unit of linear measure, and is practically one forty-millionth part of the earth's polar circumference. The unit of volumetric measure is the liter, and of gravimetric measure, the gram. The meaning of the prefixes used with the units should be thoroughly learned. The prefixes denoting amounts greater than the unit are derived from the Greek, and the abbreviations are often capitalized, while the prefixes denoting denominations smaller than the unit come from the Latin, and the abbreviations are not capitalized. Deka is 10, Hecto is 100, Kilo is 1000, Myria is 10,000, while deci is 0.1, centi is 0.01, and milli is 0.001. These last three denominations can be easily remembered as they correspond to dime, cent, and mill. A micromillimeter or "micron", used in microscopic measurements, is 0.001 of a millimeter.

LINEAR MEASURE

10 millimeters (mm.) = 1 centimeter (cm.)
10 centimeters = 1 decimeter (dm.)
10 decimeters = 1 Meter (M.)
10 Meters = 1 Dekameter (Dm.)
10 Dekameters = 1 Hectometer (Hm.)
10 Hectometers = 1 Kilometer (Km.)
10 Kilometers = 1 Myriameter (Mm.)

VOLUMETRIC MEASURE

Substitute "liter" for "meter" in the above table.

10 milliliters (mil.) = 1 centiliter (cl.)
10 centiliters = 1 deciliter (dl.)
10 deciliters = 1 Liter (L.)
10 Liters = 1 Dekaliter (Dl.)
10 Dekaliters = 1 Hectoliter (Hl.)
10 Hectoliters = 1 Kiloliter (Kl.)
10 Kiloliters = 1 Myrialiter (Ml.)

GRAVIMETRIC MEASURE

Substitute "gram" for "liter" in the above table.

10 milligrams (mg.) = 1 centigram (cg.)
10 centigrams = 1 decigram (dg.)
10 decigrams = 1 Gram (Gm.)
10 Grams = 1 Dekagram (Dg.)
10 Dekagrams = 1 Hectogram (Hg.)
10 Hectograms = 1 Kilogram (Kg.)
10 Kilograms = 1 Myriagram (Mg.)

One liter is practically one cubic decimeter, or, as declared by the U. S. Bureau of Standards, it is 1.000027 cubic decimeters. The weight of one milliliter of water at its maximum density, 4° C., is one gram. One milliliter is one-thousandth part of a liter, and one cubic centimeter is generally considered one-thousandth part of a liter, consequently equivalent to a milliliter. The term cubic centimeter (Cc.) has been used and will continue to be used for some time, although the U. S. P. uses the word "mil". In abbreviating the word gram, it is desirable to use Gm., capitalizing the G, so that it cannot possibly be mistaken for gr. or grn., which is used as the abbreviation for grain.

If the above tables are thoroughly memorized and also the following numbers, there will be but little trouble experienced in converting from one system into another.

437.5 grains = 1 av. oz.
480 grains = 1 apoth. oz.
456.3, 455.7, and 454.6 grains = 1 fl. oz. of water at 4°, 15°, and 25° C.
437.5 grains = 1 fl. oz. of water, Imp. measure
480 minims = 1 fl. oz.
39.37 inches = 1 meter
29.57 milliliters (or Cc.) = 1 fl. oz.
15.432 grains = 1 gram

Other numbers will be quickly memorized, as follows:

0.0648 gram = 1 grain
25.4 millimeters = 1 inch
16.23 minims = 1 milliliter
33.81 fluid ounces = 1 liter

To convert grams of a solid in 100 mils of solution, into grains per fluid ounce, multiply the number of grams by 4.563.

Example. One gram of a solid in 100 mils of a solution is in the same proportion as 4.563 grains in a fluid ounce.

The number of grams times 15.432 equals the number of grains of solid. $100 \times 15.432 \div 456.3 =$ number of fluid ounces in 100 mils. Divide the former by the latter, and we have $\frac{\text{No. of grams} \times 15.432 \times 456.3}{100 \times 15.432}$. The N. F. gives a rule as follows: Multiply the number of grams of solid used in making 1000 mils of the preparation by 8/7 and divide by 20; the quotient will be the number of grains in one fluid dram.

To convert grains per fluid ounce into grams per 100 mils, divide the number of grains by 4.563.

Examples

46. How many milligrams in 60 dekagrams?
47. How many cubic centimeters in 12 milliliters?
48. How many grams in 1 liter of water?
49. How many millimeters in 0.3075 centimeter?
50. How many centimeters in 0.3 meter?
51. How many milliliters in 135.4 liters?
52. Reduce 25 millimeters to meters.
53. Reduce 0.025 kilometer to millimeters.
54. Reduce 15.369 milliliters to deciliters.
55. Reduce 0.003 decigram to kilograms.
56. Reduce 479 cubic centimeters to dekaliters.
57. Reduce 0.00001 kilometer to micromillimeters.
58. How many micromillimeters in 1 meter?
59. How many hectometers in 1100.1 centimeters?
60. How many dekagrams in 85.7 cubic centimeters of water?
61. How many liters in 1 cubic meter?
62. How many hectoliters in 1795 centiliters?
63. How many kilograms in 1 cubic decimeter of water?
64. How many micromillimeters in 1 centimeter?
65. After taking out 175 centigrams from a 10 gram bottle of morphine, how many milligrams are left?
66. Add together 25 cg., 130 mg., 243 Gm., 4.70 Dg., 0.03 Kg., and express in dg.

67. Write five thousand eleven centigrams in figures expressed in milligrams.

68. Express one-half of a milliliter in figures of a decimal part of a liter.

69. How many cubic centimeters in 1 pint?

70. How many pints in 1 liter?

71. How many grams in 1 quart of water?

72. How many liters in 1 gallon?

73. How many grains in 1 dekagram?

74. How many grains in 1 cubic centimeter of water?

75. How many inches in 25 millimeters?

76. How many cm. in 4 in.?

77. How many minims in 1 Cc.?

78. How many ozs. in 1 L.?

79. How many mils in 1 gal.?

80. How many Cc. in 1 fl. dr.?

81. How many mg. in 1 gr.?

82. How many Gm. in 1 oz. av.?

83. Give in grains the difference between 32 av. ozs. and 1 Kg.

84. Convert into the common system the U. S. P. formula for the solution of magnesium citrate.

85. Convert into the common system the U. S. P. formula for compound glycyrrhiza mixture.

86. How many grains of each ingredient are required to make 1 lb. of compound glycyrrhiza powder?

87. How many grains of potassium and sodium tartrate in one average dose of compound effervescing powder as given in the U. S. P.?

88. How many cubic centimeters in 1 cubic inch?

89. How many mils in 1 fl. dr.?

90. How many minims in 0.04 L.?

91. How many grs. in 1 mg.?

92. How many apoth. ozs. in 453 Gms.?

93. One fl. oz. of water weighs how many av. ozs.?

94. What is the weight in Gms. of 1 Imp. fl. oz. of water?

95. How many grains of each ingredient are required to make 100 compound cathartic pills?

96. If 4 drs. of acetanilid are taken out of a 1 oz. bottle in filling prescriptions, how many grains are left?

97. How many grams of the other ingredients must be mixed with 11 grams of acetanilid to make it into compound acetanilid powder, N. F.?

98. If you buy 5 L. of alcohol and at different times use 1 pt. 3 ozs. $5\frac{1}{2}$ drs. 45 min., how many mils are left?

99. If 1 pt. of elixir contains $1\frac{1}{3}$ apoth. ozs. of a drug, how many Gms. of the drug are there in 1 Cc.?

100. How much potassium iodide must be used to make $\frac{1}{4}$ L. of a solution so that every 4 Cc. will contain 33 dg.?

101. An empty bottle weighs 520 Gms.; filled with water it weighs 1 Kg. 720 Gms.; how many fl. ozs. does it contain?

102. From 475 cm. subtract 1 M. 0.69 cm. and express in mm.

103. What is the dose of potassium bromide if 500 Cc. of a solution contain $\frac{2}{5}$ of a Kg. and 4 Cc. are taken at a dose?

104. The dose of strychnine is $\frac{1}{32}$ of a gr.; how much must be used in making 100 Cc. of solution so that a fl. dr. will contain a dose?

105. The dose of arsenic is $\frac{1}{10}$ gr.; how many doses in 1 fl. dr. of Fowler's solution every 100 Cc. of which contains 1 Gm. of arsenic?

106. If the price per liter of a liquid is $2.11, what is the price per pint?

107. A formula calls for a filter paper 11 cm. in diameter; how many inches would that be?

108. In dispensing an English prescription calling for 2 fl. ozs. of tinct. chloride of iron, how many minims wine measure would you use?

109. A prescription calls for 0.00032 Gm. of atropine in each capsule, what part of a grain would this be?

In the following prescription, change the amounts from the metric system to the common system. In writing metric prescriptions it is customary to replace the decimal points with a line and to leave out the denominations, it being understood that the numbers on the right-hand side of the line are decimals and those on the left-hand side are whole numbers of grams in case of solids or milliliters in case of liquids.

110. ℞	Quininæ sulphatis	4	
	Ferri phosphatis sol.	8	
	Strychninæ sulphatis		065
	Acidi phosphorici dil.	15	
	Syrupi zingiberis	60	
	Aquæ	q. s. ad 120	

111. Convert into the common system the following prescription:

℞	Aloin	1	30
	Strychnine	0	05
	Ext. belladonna	0	8
	Ipecac	0	4
	Oil peppermint	0	5
	Glycyrrhiza	4	65

112. Convert the following prescription into the metric system:

℞	Quinine valerate	$\frac{1}{2}$ oz.
	Strychnine sulph.	$2\frac{1}{2}$ grs.
	Co. tinct. cudbear	$\frac{1}{2}$ fl. oz.
	Elixir	32 fl. ozs.

STOCK SOLUTION

113. One fluid ounce of a stock solution contains 12 grains of strychnine sulphate. How many minims of the stock solution are required in filling a 2 fl. oz. prescription which is to be taken in teaspoonful doses, if $\frac{1}{64}$ of a grain of the strychnine is to be taken at a dose?

114. How many fluid ounces of liquefied phenol will be required to make a gallon of a solution which is to contain one part by volume of liquefied phenol to 31 parts of water?

115. A stock solution of mercuric chloride is made so that 3 fl. ozs. contain 30 grains of the chloride. How many minims of this solution must be taken to make 3 gallons of a solution of 1 in 1000?

116. A pint of solution contains 4 av. ozs. of potassium iodide. How many Cc. must be taken to get 1 Gm. of potassium iodide?

117. A pint of solution contains 2.25 apoth. ozs. of corrosive sublimate. How many minims of this solution must be used in making 1 gallon of a solution 1 in 2000?

118. Twelve fl. ozs. of a stock solution contains $\frac{1}{2}$ apoth. oz. of potassium chlorate. How many minims must be used in making a pint of a solution of 1 to 99?

119. Six grams of potassium permanganate are dissolved in sufficient water to make 100 mils. How many mils of this solution must be used in making a liter of a solution 1 in 40?

120. Twelve grains of morphine sulphate are dissolved in water to make $\frac{1}{2}$ fl. oz. A 4 fl. oz. prescription is to be taken in dessertspoonful

doses and each dose is to contain $\frac{1}{4}$ grain of morphine sulphate. How many minims of the stock solution will be necessary?

121. Having on hand a stock solution containing 6 Gms. of mercuric chloride dissolved in water to make 100 mils, how many Cc. of this must be used in making 5 L. of a 1 in 2000 solution?

122. Having on hand a stock solution made by dissolving 1 Kg. of potassium iodide in water to make 1 L., how many minims of this solution would be used in filling a prescription calling for 2 ozs. of potassium iodide?

SPECIFIC GRAVITY

Specific gravity is the comparison of the weight of anything with the weight of something else taken as the standard. Water is taken as the standard for liquids and solids. For gases hydrogen is taken as the standard in technical calculations, and air in ordinary work. The pharmacist rarely has anything to do with specific gravity of gases. The specific gravity of a liquid or solid is found by dividing the weight of the substance by the weight of an equal volume of water. There are two weights, therefore, which must always be determined—the weight of the substance and the weight of the same bulk of water. Specific gravity shows how many times lighter or heavier the substance is than water. Density refers to the weight of a body compared with its volume.

SPECIFIC GRAVITY OF LIQUIDS

In case of liquids, there are different methods of getting the two weights—by means of the specific gravity flask or pycnometer, by the hydrometer, by the loaded cylinder, and by Lovi's beads. The pycnometer furnishes the best and most accurate method. There are various forms of pycnometers, the simplest being a small flask with a mark on its neck. The best one for ordinary use is a flask which has a side arm consisting of a capillary tube closed by a ground-glass cap, and the mouth of the flask closed by having the stem of a thermometer ground to fit it. What is desired in getting specific gravity is to get the volumes of the two liquids the same and to keep them so while weighing. The pycnometer is first thoroughly cleaned and dried, then weighed. It is next filled with the liquid, wiped off well and weighed again. It is then cleaned, filled with water and weighed. The weight of the pycnometer subtracted from the other two weights gives the weights of equal volumes of liquids. In using a pycnometer it is not necessary to reweigh it every time, but it should be weighed occasionally to see that it does not change in weight.

For anything but the crudest work, it is necessary to note the temperature of the substance and also of the water. It is preferable to have them the same, but in any case the temperature should be stated. $\frac{25^\circ}{25^\circ}$ C. means that both were weighed at 25° C. while $\frac{20^\circ}{25^\circ}$ C. means that the substance was weighed at 20° C. and the water at 25° C. Specific gravity is sometimes taken at 4.0° C., 15.0° C., 15.6° C., or at 25.0° C. The U. S. P. usually gives specific gravities at $\frac{25^\circ}{25^\circ}$ C., and this temperature can be obtained and kept at any season of the year much easier than the other temperatures given. Barometric pressure has some effect on specific gravity, but is generally ignored.

Example. A pycnometer weighs 20 Gms.; filled with water the weight is 44 Gms.; filled with glycerin the weight is 50 Gms.; what is the specific gravity of glycerin?

Solution. $44-20=24$, the weight of water. $50-20=30$, the weight of the same volume of glycerin. $30\div 24=1.25$, the sp. gr. of glycerin.

A hydrometer is an instrument consisting of a weighted bulb with a stem, made to float on a liquid, the stem being graduated so as to show the specific gravity of the liquid. Hydrometers are generally made in sets of two (one for liquids lighter than water and one for liquids heavier than water) or more. The more hydrometers in a set the more accurate are they, other conditions being equal, because the graduations can be separated to a greater distance without having such a long unwieldy stem. Hydrometers are sometimes made to be used in certain liquids, and are then known by certain names, as, alcoholometer, urinometer, lactometer, etc. Baumé's hydrometer, sometimes used in manufacturing concerns, is graduated to an arbitrary scale and does not show specific gravity, but the degrees Baumé can be converted into specific gravity by the following formulas:

For liquids heavier than water $\dfrac{145}{145-\text{B.}^\circ}=\text{sp. gr.}$

For liquids lighter than water $\dfrac{140}{130+\text{B.}^\circ}=\text{sp. gr.}$

Nicholson's hydrometer is made on a little different principle, as the stem has but one graduation and carries a pan on which weights may be placed so as to make the instrument sink to the mark.

To determine the specific gravity of a liquid by means of a loaded cylinder, the loaded cylinder is first weighed in air; it is then suspended from the arm of the balance, and while immersed in water it is weighed again. The difference between the two weights is the weight of water displaced. It is then suspended from the arm of the balance and while immersed in the liquid to be tested it is weighed again. The difference between this weight and the weight of the cylinder in air is the weight of the liquid displaced. Since the volumes of liquids displaced are the same this weight divided by the weight of water displaced gives the specific gravity.

EXAMPLE. A piece of zinc weighs 28 Gms. in air; 24 Gms. in water; 23 Gms. in glycerin; what is the specific gravity of glycerin?

Solution. $28-24=4$, the weight of water displaced. $28-23=5$, the weight of glycerin displaced. $5 \div 4=1.25$, the sp. gr. of glycerin.

Lovi's beads are beads of different specific gravities, the specific gravity of each being marked on it. When these are put into the liquid, some will sink and some will float, but one will remain any place in the liquid where it is placed, and it has the same specific gravity as the liquid.

SPECIFIC GRAVITY OF SOLIDS

A pharmacist will not find it necessary to get the specific gravity of solids as frequently as of liquids, but he should know how to do so. The methods of getting the specific gravity vary with the solids as to whether they are heavier than water and insoluble, lighter than water and insoluble, soluble in water, or in the form of a powder. It is necessary to keep in mind two principles—a floating body displaces its own weight and an immersed body displaces its own volume. **If a body heavier than water** is weighed in air and then weighed while immersed in water, it will apparently weigh less in water. It will displace its own volume of water, and the difference between its weight in air and its weight in water is the weight of water displaced and consequently the weight of an equal volume of water. We have then the two necessary numbers, the weight of the solid and the weight of an equal volume of water.

Example. A piece of iron weighs 24 Gms. in air and 21 Gms. suspended in water; what is the specific gravity?

Solution. $24-21=3$, the weight of water displaced. $24\div 3=8$, the specific gravity of iron.

In case the body is lighter than water and insoluble in it, it is necessary to use a sinker heavy enough to cause the immersion of the body. The body is weighed in air; the sinker is weighed in water; the body and sinker fastened together are weighed in water. To find the weight of the water displaced or the equal volume of water, the difference between the weight of the sinker in water and the weight of the sinker and body together in water is added to the weight of the body in air. A floating body displaces its own weight, that is, its weight in air. The weight of the water displaced by that part of the body immersed, when the body is floating, is the weight of the body in air. The apparent weight of the body and sinker together in water is less than the weight of the sinker alone in water, or the body buoys up the sinker. The difference between these two weights is the weight of the water displaced by that part of the body which is not immersed when it is floating. Hence the sum of the weight of the body in air and the difference in weight between the sinker in water and the sinker with the body in water is the weight of the water displaced by the light body, or the weight of an equal volume of water.

Example. A piece of cork weighs 1.464 Gms. in air, a piece of metal weighs 13.2 Gms. in water; the cork and metal together in water weigh 8.364 Gms.; what is the specific gravity of cork?

Solution. $13.2-8.364=4.836$, the weight of water displaced by that part of the cork not immersed when it is floating. $4.836+1.464=6.3$, the weight of water displaced by the cork. $1.464\div 6.3=0.23$, specific gravity of cork.

Or the specific gravity of a solid lighter than water but insoluble in it can be obtained by getting the weight of the body in air; the weight of the sinker in air; the weight of the sinker in water; the weight of the body and sinker together in water. From the combined weight of the body and sinker in air subtract the combined weight of the body and sinker in water, and this gives the loss of the two in water. Find the difference between this and the loss of the sinker in water and it will be the weight of the water displaced by the body, or the weight of an equal volume of water.

EXAMPLE. A piece of cork weighs 1.464 Gms. in air; a piece of metal weighs 15.4 Gms. in air or 13.2 Gms. in water; the cork and metal together in water weigh 8.364 Gms.; what is the specific gravity of cork?

Solution. $1.464+15.4=16.864$, the weight of cork and metal in air. $16.864-8.364=8.5$, the weight of water displaced by both. $15.4-13.2=2.2$, the weight of water displaced by the metal. $8.5-2.2=6.3$, the weight of water displaced by the cork. $1.464\div 6.3=0.23$, the sp. gr. of cork.

If the body is soluble in water it is necessary to use some liquid in which it is not soluble. Find the specific gravity, using a liquid in which the solid is insoluble just as though the liquid were water (this is the specific gravity of the body taking that liquid as the standard), and then multiply this specific gravity by the specific gravity of the liquid used; the product will be the specific gravity of the body taking water as the standard.

If the body is in powdered form it is necessary to use a specific gravity flask. The flask is first weighed, then filled with water and weighed, and the difference is the weight of water which the flask will contain. A known weight of powder is placed in the flask, the flask then filled with water and the weight of the contents of the flask obtained. From the combined weight of powder and water that can be in the flask at the same time subtract the weight of the powder and this gives the weight of water that can be in the flask at the same time that the powder is in it. The weight of this water is subtracted from the weight of water that the flask will hold without the powder, and the difference is the weight of water displaced or the weight of an equal volume of water.

EXAMPLE. A sp. gr. flask weighs 25 Gms.; filled with water it weighs 75 Gms. If 12 Gms. of a powder are put into the flask and then filled with water, the weight is 77 Gms.; what is the specific gravity of the powder?

Solution. $75-25=50$ Gms. water. $77-25=52$ Gms., weight of powder and water in the flask at the same time. $52-12=40$ Gms., the weight of water that can be in the flask at the same time that the powder is in it. $50-40=10$ Gms., the weight of water displaced by the powder. $12\div10=1.2$, the sp. gr. of the powder.

Sometimes the amount of solid is small, as in case of some fats. We can make up a mixture of two liquids, as alcohol and water, in such proportions that the fat will neither sink nor float in it (in which condition it has the same sp. gr. as the fat), and then get the sp. gr. of the liquid.

SPECIFIC VOLUME

Specific volume is just the converse of specific gravity. It is the volume of a substance compared with the volume of an equal weight of some substance taken as the standard. For solids and liquids, water is taken as the standard. To find specific volume, divide the volume of the substance by the volume of an equal weight of water. Or, divide unity by the specific gravity.

EXAMPLES. One hundred mils of alcohol weigh 82 Gms.; what is the specific volume?

Solution. $100 \div 82 = 1.219$, sp. vol. of alcohol.

The specific gravity of alcohol is 0.82; what is the specific volume?

Solution. $1 \div 0.82 = 1.219$, sp. vol. of alcohol.

EXAMPLES

123. A flask holds 25 Gms. of water or 46 Gms. of sulphuric acid; what is the specific gravity of the acid?

124. A flask holds 25 Gms. of water or 31.75 Gms. of glycerin; what is the sp. gr. of glycerin?

125. A cylinder which holds 50 lbs. of mercury, holds 3.85 lbs. of water; what is the sp. gr. of mercury?

126. If 500 Cc. of alcohol weigh 410 Gms., what is the sp. gr.?

127. A sp. gr. flask holds 50 Cc. of water or 36 Gms. of ether; what is the sp. gr. of ether?

128. If 1 fl. oz. of hydrochloric acid weighs 542.997 grains, what is the sp. gr.?

129. What is the sp. gr. of syrup, if 1 fl. oz. weighs 606.879 grains?

130. An av. oz. of a volatile oil measures 36 Cc.; what is the sp. gr.?

131. Ten Cc. of a liquid weigh 19.5 Gms.; what is the sp. gr.?

132. If 50 Gms. of a liquid measure 43.47 Cc., what is the sp. gr.?

133. If 50 Cc. of nitric acid weigh 71 Gms., what is the sp. gr.?

134. An Imp. gal. of oil of peppermint weighs 109 av. ozs.; what is the sp. gr.?

135. A piece of glass weighs 5 Gms. in air; 4 Gms. when suspended in water; 4.2 Gms. when suspended in oil; what is the sp. gr. of oil?

136. A plummet in air weighs 75 grs.; in water 60 grs.; in acid 50 grs.; what is the sp. gr. of the acid?

137. A plummet loses 25 Gms. in water and 30 Gms. in syrup; what is the sp. gr. of syrup?

138. A piece of iron weighs 43 Gms. in air; 28 Gms. in water; 24.25 Gms. in glycerin; what is the sp. gr. of glycerin?

139. A nail weighs 5 Gms. in air and 4.5 Gms. in water; what is the sp. gr. of the nail?

140. A piece of lead weighs 70 grs. in air and 64 grs. in water; what is the sp. gr. of the lead?

141. A piece of gold weighs 99 grs. in air and 94 grs. in water; what is the sp. gr. of gold?

142. A piece of silver weighing 8.4 Gms. in air loses 0.8 Gm. on being immersed in water; what is the sp. gr. of silver?

143. What is the sp. gr. of a crystal which weighs 5 Gms. in air and 2 Gms. in water?

144. A solid weighs 5 ozs.; the same volume of water weighs 1 oz.; what is the sp. gr.?

145. A graduated cylinder contained 20 Cc. of water; a solid weighing 8 Gms. was dropped into the water and the water then reached the 27 Cc. mark; what is the sp. gr. of the solid?

146. A crystal weighing 77 grs. in air, when dropped into a graduate containing water increases the contents of the graduate 60 minims; what is the sp. gr. of the crystal?

147. One mil of a certain solid weighs 2.4 Gms.; what is the sp. gr.?

148. A small piece of fat is put into a mixture made by adding just enough of alcohol to water so that the fat will remain in any position in the mixture. A pycnometer holding 25 Gms. of water will hold 23.5 Gms. of the mixture of alcohol and water; what is the sp. gr. of the fat?

149. A crystal of ferrous sulphate weighs 7.3 Gms. in air and 5.1 Gms. in oil of turpentine, sp. gr. 0.86; what is the sp. gr. of the sulphate?

150. A piece of alum weighs 165.4 grs. in air and 97.7 grs. in alcohol sp. gr. 0.82; what is the sp. gr. of alum?

151. A crystal of Rochelle salt weighing 12.7 Gms. when put into 25 Cc. chloroform increases the volume of the contents to 35.2 Cc.; what is the sp. gr. of the salt?

152. A piece of cork weighs 5 Gms. in air; a piece of metal weighs

45 Gms. in air and 39 Gms. when immersed in water; the cork and metal fastened together and immersed in water weigh 24 Gms.; what is the sp. gr. of the cork?

153. A piece of paraffin weighs 7.5 Gms. in air; a piece of metal weighs 30 Gms. in air and 27 Gms. in water; the paraffin and metal together weigh 26.5 Gms. in water; what is the sp. gr. of paraffin?

154. A piece of wax weighs 75 grs. in air; a piece of metal weighs 300 grs. in air and 270 grs. in water; together in water they weigh 267 grs.; what is the sp. gr. of wax?

155. A piece of cork weighs 10 Gms. in air; a piece of metal weighs 60 Gms. in water; the cork and metal together in water weigh 28 Gms., what is the sp. gr. of the cork?

156. A piece of wax weighs 10 Gms. in air; a sinker weighs 6 Gms. in water; the wax and sinker together weigh 5 Gms. in water; what is the sp. gr. of wax?

157. A piece of wax weighs 20 Gms. in air; the sinker and wax together in water weigh 0.5 Gms. less than the sinker alone in water; what is the sp. gr. of the wax?

158. A light solid weighs 15 Gms. in air; a sinker is counterpoised in water; when the light solid is attached to the sinker it takes 2 Gms. to overcome the buoyant effect of the light body; what is its sp. gr.?

159. A light solid soluble in water weighs 15 Gms.; a sinker in ether (sp. gr. 0.72) weighs 24 Gms.; the sinker and solid together in ether weigh 23 Gms.; what is the sp. gr. of the solid?

160. A pycnometer holds 25 Gms. of water. If 7 Gms. of a powder are put into the flask and then the flask filled with water, the powder and water together weigh 27 Gms.; what is the sp. gr. of the powder?

161. A sp. gr. flask weighs 175 grs.; when filled with water it weighs 275 grs.; when 25 grs. of sand are put into the flask and the flask filled with water the weight is 295 grs.; what is the sp. gr. of sand?

162. A pycnometer holds 50 Gms. of water; 12 Gms. of calomel are put into the flask and the flask then filled with water; the combined weight of calomel and water is 60.8 Gms.; what is the sp. gr.?

163. A pycnometer holds 25 Gms. of water or 18 Gms. of ether; it will hold at the same time 10 Gms. of a salt and 15 Gms. of ether; what is the sp. gr. of the salt?

164. A bottle holds 452 grs. of water or 370 grs. of alcohol; if 125 grs. of ammonium chloride are put into the bottle and then the bottle

filled with alcohol the combined weight is 445 grs.; what is the sp. gr. of the ammonium chloride?

165. A certain liquid measures 50 Cc. while the same weight of water measures 45 Cc.; what is the specific volume?

166. Ten mils of a liquid weigh 13 Gms.; what is the sp. vol.?

167. One av. oz. of a solution measures 27 Cc.; what is the sp. vol.?

168. The sp. gr. of glycerin is 1.25; what is the sp. vol.?

169. The sp. gr. of alcohol is 0.82; what is the sp. vol.?

170. A certain solid weighs 5 Gms. and measures 6 Cc.; what is the sp. vol.?

171. A solid displaces 30 Gms. of water and 27 Gms. of oil; what is the sp. vol. of the oil?

172. Ether has the sp. vol. of 1.4; what is the sp. gr.?

173. Hydrochloric acid has the sp. vol. of 0.84; what is the sp. gr.?

TO CONVERT VOLUME TO WEIGHT AND WEIGHT TO VOLUME

Liquids are often bought by weight and sold by volume. Formulas sometimes call for weight when it is more convenient to use measure, or the reverse may be true. It becomes necessary to be able to determine how much a certain volume of liquid weighs or how much a given weight measures.

Case I. Having given volume and specific gravity, to find weight. *Rule.* Multiply the weight of an equal volume of water by the sp. gr.

Example. A fl. oz. of glycerin, sp. gr. 1.25, weighs how many grains?

Solution. A fl. oz. of water weighs 456.3 grs. Glycerin is 1.25 times as heavy as water. $456.3 \times 1.25 = 570.3$ grs., the weight of one fluid ounce of glycerin.

Case II. Having given weight and specific gravity, to find volume. *Rule.* Divide the given weight by the specific gravity and the quotient is the weight of water whose volume is the same as that of the given liquid. Find the volume of this weight of water and that is the volume of the liquid.

EXAMPLE. One oz. av. of glycerin, sp. gr. 1.25, measures how many minims?

Solution. 437.5 grs. (1 av. oz.) ÷ 1.25 = 350 grs., the weight of water whose volume is the same as that of the glycerin. One grain of water measures 480 ÷ 456.3 = 1.05 minims. 350 × 1.05 = 367.5. One fl. oz. of glycerin measures 367.5 minims.

EXAMPLES

174. Alcohol has a sp. gr. of 0.82; what is the weight of 2 liters?

175. Glycerin has a sp. gr. of 1.25; what is the weight of 2 liters?

176. Glycerin has a sp. gr. of 1.25; what is the weight in av. ozs. of 1 pt.?

177. What is the weight in lbs. of 1 gal. of ammonia water, sp. gr. 0.96?

178. How many av. ozs. in 5 pts. of syrup of iodide of iron, sp. gr. 1.35?

179. How many pounds in 1 gal. of U. S. P. syrup?

180. Find the weight in grains of 250 minims of nitric acid, U. S. P.

181. What is the volume of 1 Kg. of sulphuric acid, sp. gr. 1.83?

182. How many lbs. in 1 gal. of the same sulphuric acid?

183. What is the cost of 5 pts. of solution of ferric chloride at $0.15 a lb., sp. gr. 1.315?

184. U. S. P. alcohol costs $2.53 a gal.; how many lbs. can be bought for $10.00?

185. A formula calls for 143 Gms. of hydrochloric acid, 1.15 sp. gr.; how many Cc. would be used?

186. A carboy of ammonia water contains 40 Kg.; how many pints will there be?

187. How many minims in 157 grs. of nitric acid, sp. gr. 1.4?

188. A formula calls for 145 grains of dilute hydrochloric acid, sp. gr. 1.049, how many minims would be used?

189. How many fl. ozs. in 10 lbs. of Monsel's solution, sp. gr. 1.54?

190. Will a druggist gain or lose if he buys chloroform, sp. gr. 1.48, at $0.50 a lb. and sells it at $1.50 a liter?

191. How large a bottle will be required to hold 10 lbs. of ether, sp. gr. 0.72?

192. The sp. vol. of ether is 1.388, what is the volume of 1 Kg. of ether?

193. A hydrometer weighs 200 grs.; how much should it weigh to sink to the same point in nitric acid sp. gr. 1.4?

194. A hydrometer displaces 14.5 Gms. of water; how many grs. of ether, sp. gr. 0.72, will it displace and how many minims?

195. A hydrometer weighs 25 Gms. and sinks to a certain point in water; what weight must be added to it to make it sink to the same point in glycerin, sp. gr. 1.25?

196. Equal volumes of alcohol (sp. gr. 0.82) and chloroform weigh respectively 41 and 73.5; what is the sp. gr. of chloroform?

197. How many Gms. of a liquid, sp. gr. 1.25, will it take to fill a bottle 500 Cc. capacity?

198. What will be the sp. gr. of a mixture of equal weights of alcohol (sp. gr. 0.82), ether (sp. gr. 0.72), and chloroform (sp. gr. 1.45), making no allowance for contraction?

199. What will be the sp. gr. of the above mixture if equal volumes are used?

200. If a piece of zinc weighs 15 Gms. in air and has a sp. gr. of 7.0; what will be its weight when immersed in water?

201. If a piece of metal weighs 25 Gms. in air and 21 Gms. in water, what will it weigh in a liquid having a sp. gr. of 0.95?

202. Oil of lemon costs $1.40 a lb. and has a sp. gr. of 0.85; what is the cost of 1 fl. oz.?

203. Mercury costs $1.40 a pound and has a sp. gr. of 13.5; what will a pint cost?

204. The sp. vol. of oil of turpentine is 1.16; how many ozs. will a pint weigh?

205. If a solid weighs 27 Gms. in air and the same volume of water weighs 7 Gms., what will this solid weigh when immersed in water?

PERCENTAGE

The principles upon which percentage is based and which have been learned in the preparatory schools are the same as those which are used in pharmacy. In arithmetic students have applied percentage chiefly to money; they have learned how to find the per cent, percentage (interest), and base (capital), when certain factors are given. The same rules apply in pharmacy and the cases are the same. It must be kept in mind that we are working with solids, liquids, or gases and the per cent given may be per cent by weight or by volume. When a per cent is given, it is generally understood to be per cent by weight whether the substance is a solid, liquid, or gas, unless otherwise specified, except in case of alcohol. It is customary to speak of alcohol, meaning per cent by volume, but to avoid misunderstanding it should be stated whether the per cent is by weight or by volume.

CASE I. To find the amount of an ingredient (percentage), in a mixture, when total quantity (base) and per cent are given. *Rule.* Multiply the amount of the substance by the per cent and the product is the percentage or the amount of the ingredient.

EXAMPLES. How many grains of morphine in 100 grains of opium which contains 9 per cent of morphine?

Solution. $100 \times 0.09 = 9$. 9 grains of morphine.

How many grams of ferric chloride in 1 liter of solution which contains 10.5 per cent of ferric chloride and has a sp. gr. of 1.30?

Solution. 1000 mils of solution weigh 1300 Gms. $1300 \times 0.105 = 136.5$ Gms.

There are 4 mils of oil of juniper in 1000 mils of compound spirit of juniper. How many grains of the oil, sp. gr. 0.86, in 1 pint of the spirit?

Solution. There are 0.4 mil of the oil in 100 mils of spirit, or 0.4 per cent by volume. One pint of spirit contains 16×0.004 or 0.064 fl. ozs. of oil. 0.064 fl. ozs. of oil, sp. gr. 0.86, weighs $0.064 \times 456.3 \times 0.86 = 25.11$ grs., the weight of juniper oil in the spirit.

CASE II. To find the per cent when the amount of the mixture (base) and the amount of the ingredient (percentage) are given. *Rule.* Divide the amount of the ingredient by the amount of the mixture and multiply by 100 and the product is the per cent.

EXAMPLES. If 20 Gms. of cinchona contain 1 Gm. of quinine, what is the per cent of quinine?

Solution. $1 \div 20 \times 100 = 5$; 5 per cent of quinine.

What is the per cent by volume of ethyl nitrite, sp. gr. 0.92, in a spirit of nitrous ether which contains 4 per cent of nitrite by weight and has a sp. gr. of 0.82?

Solution. For convenience take 100 mils of spirit. It contains $(100 \times 0.82 \times 0.04)$, 3.28 Gms. of ethyl nitrite which measure $(3.28 \div 0.92)$3.56 mils. 100 mils of spirit contain 3.56 mils of ethyl nitrite or 3.56 per cent by volume.

CASE III. To find the amount of a mixture (base) that can be made when the per cent and the amount of ingredient (percentage) are given. *Rule.* Divide the amount of ingredient by the per cent and multiply by 100.

EXAMPLES. How many grains of a 4 per cent solution of cocaine hydrochloride can be made from a dram of the salt?

Solution. $60 \div 4 \times 100 = 1500$ grs., the weight of solution.

Ten pounds of a certain pilular extract of belladonna contains 0.95 per cent of alkaloids and 30 per cent of moisture. How much starch must be added to the extract after it has been dried to make it contain 1.25 per cent of alkaloids?

Solution. The 10 lbs. of extract contain 0.095 lb. of alkaloids (0.95 per cent of 10 = 0.095) and 3 lbs. of moisture or 7 lbs. of solid matter. The finished product must contain 0.095 lb. of alkaloids and this must be 1.25 per cent of the finished product. If 0.095 is 1.25 per cent of the finished product, 1 per cent is 0.095 ÷ 1.25 and 100 per cent is 100 times that, which is 7.6. The finished product weighs 7.6 lbs. and 7 lbs. of it comes from the extract, $7.6 - 7 = 0.6$ lb. of starch must be added.

EXAMPLES

206. How much quinine in 95 Gms. of cinchona bark, if the bark contains 5 per cent quinine?

207. How many grs. of absolute nitric acid in 1 av. oz. of the U. S. P. acid? In 1 fl. oz.?

208. How much anhydrous ferric chloride in 1 pt. of tincture of ferric chloride which has a sp. gr. of 1.005 and contains 13.3 per cent ferric chloride?

209. A sample of gentian yields 20 per cent extract; how many ozs. of extract can be obtained from 5 lbs. of gentian?

210. If 700 grs. of opium are used in making 1 lb. of Dover's powder, what is the per cent of opium?

211. If 1 part of water dissolves 1.5 parts of potassium iodide, what is the per cent strength of the solution?

212. If 1 part of water dissolves $\frac{1}{12}$ part of potassium chlorate, what is the per cent strength of a saturated solution?

213. Sodium sulphate is soluble in 2.8 parts of water; what is the per cent of a saturated solution?

214. Strychnine is soluble in 6420 parts of water; what is the per cent of a saturated solution?

215. How much water must be added to 15 grs. of cocaine hydrochloride to make a 4 per cent solution?

216. How much of an 0.85 per cent solution can be made from 10 Gms. of sodium chloride?

217. How many ozs. of phenol must be added to 1 lb. of glycerin to make a 20 per cent phenol solution?

218. To make 1 Kg. of a 5 per cent solution of sodium hydroxide, how many Gms. of sodium hydroxide 95 per cent pure must be used?

219. What is the per cent of cocaine hydrochloride in a solution made by dissolving 25 Gms. in a sufficient amount of water to make 600 Gms.?

220. Solution of lead subacetate has a sp. gr. of 1.235 and contains 25 per cent. of lead subacetate. How many grains of lead subacetate in 1 fl. oz. of the dilute solution made by mixing 40 Cc. of the stronger solution with 960 Cc. of water?

221. Ammonia water of 28 per cent has a sp. gr. of 0.8969; how many Cc. of this must be used in making 1 L. of a 10 per cent ammonia, having a sp. gr. of 0.9585?

222. How many Gms. of absolute alcohol in 1 L. of a 52 per cent alcohol by vol. if absolute alcohol has a sp. gr. of 0.787?

223. How many Gms. of absolute alcohol in 1 L. of alcohol having a sp. gr. of 0.925 and containing 52 per cent by weight?

224. What is the per cent by weight of absolute alcohol in a sample which has a sp. gr. of 0.8095 and contains 95 per cent by volume, the sp. gr. of absolute alcohol being 0.787?

225. What is the per cent by volume of absolute alcohol in a sample which contains 46 per cent by weight and has a sp. gr. of 0.941, the sp. gr. of absolute alcohol being 0.787?

226. How many Gms. of chloroform in 1 L. of spirit of chloroform if the spirit contains 6 per cent by volume and chloroform has a sp. gr. of 1.47?

227. How many Gms. of glycerin, sp. gr. 1.25, in 1 L. of fluidext. of cinchona which contains 10 per cent by volume of glycerin?

228. If gum opium contains 9 per cent morphine and 22 per cent moisture, what will be the per cent of morphine in the opium when it is dried?

229. How much water must be added to 1 lb. of U. S. P. 36 per cent acetic acid to make it into the 6 per cent acid?

230. How many mils of water would you add to 500 Gms. of 31.9 per cent hydrochloric acid to make it into 10 per cent acid?

231. If 5 lbs. of cinchona bark containing 4.5 per cent quinine are

mixed with 7 lbs. containing 8.4 per cent quinine, what is the per cent of quinine in the mixture?

232. In 100 Cc. of syrup, sp. gr. 1.31, there are 85 Gms. of sugar; what is the per cent?

233. If equal weights of two solutions of salts containing 15 per cent and 7 per cent are mixed what is the per cent of the salt in the mixture?

234. A syrupy extract of nux vomica contains 45 per cent moisture and 3.5 per cent strychnine; how much sugar of milk should be added to 1 lb. of the extract after it is dried, so as to make an extract containing 5 per cent strychnine?

235. How much morphine can be obtained from 1 lb. of dried opium which is made from opium containing 25 per cent moisture and 8 per cent morphine?

236. If belladonna yields 5 per cent extract, how much extract can be obtained from 1 Kg. of a 10 per cent tincture?

237. Indian cannabis yields 12 per cent extract; how much fluidext. will be equivalent to 1 Gm. of extract?

238. If a drug yields 5 per cent extract, how much extract can be obtained from 1 lb. of a 10 per cent tincture?

239. Commercial colocynth is a mixture of pulp and seeds and the extract should be made from the pulp alone. If a sample contains 30 per cent pulp and 70 per cent seed how much of it must be used to make 1 Kg. of compound extract of colocynth if the pulp yields 30 per cent extract and the compound extract contains 16 per cent of the simple extract?

240. How much sugar of milk must be added to 1 lb. 7 ozs. 25 grs. of a syrupy extract of opium which contains 32 per cent moisture and 18 per cent morphine so that when it is dry it will contain 20 per cent morphine?

241. If 1 Kg. of moist extract of colchicum contains 15 per cent moisture and 1.7 per cent colchicine, how much sugar of milk must be added so that when dry the extract will contain 1.4 per cent colchicine?

242. Granulated opium contains from 10.0 to 10.5 per cent morphine and 10 Gms. are used to make 100 Cc. of laudanum. How much gum opium containing 9.0 per cent morphine must be used to make 1 pt. of laudanum of the required morphine strength?

243. How many grs. of morphine in 1 fl. oz. of paregoric, if 0.4 Gm. of opium containing 10 per cent morphine are used to make 100 mils?

244. Bottles are listed at $6.00 a gross. A discount of 50 and 7 per cent is allowed and 3 per cent for cash. What is the cost if cash is paid?

245. U. S. P. solution of potassium hydroxide has a sp. gr. of 1.046 and contains 5 per cent of the hydroxide. How many fl. ozs. of water must be added to a solution having 1.101 sp. gr. and containing 12 per cent so as to make 1 gal. of the 5 per cent?

246. After extracting 25 Gms. of myrrh with alcohol, the residue weighed 8 Gms. What is the per cent of extract?

247. How many Gms. of glacial acetic acid are required to make 1 pt. of 36 per cent acid of 1.045 sp. gr.?

248. How much cocaine hydrochloride is required to make up a *full* four fluid ounce solution of exactly 5 per cent?

249. How many grains of potassium chlorate should be used in making up a *full* pint of a solution of exactly 8 per cent?

250. Physiological salt solution contains 0.85 per cent of sodium chloride; how much can be made from 10 Gms. of sodium chloride?

251. How much boric acid must be added to 100 mils of glycerin to make a 7 per cent solution?

252. How many grains of a saturated solution of borax should be taken to get 1 av. oz. of borax?

253. A lot of opium was found to assay 0.9 Gm. of morphine in 100 Cc. How many Gms. of morphine should be added to 1 gal. of it to bring it up to the minimum U. S. P. requirement?

254. A discount on a bill of goods was 35, 12, and 2 per cent. In marking the cost of the goods, what per cent should be deducted from the list price?

255. If it costs 20 per cent on gross sales to do business, at what price must an article be sold to make a net profit of 15 per cent on selling price if it cost $1.00?

256. If it costs 25 per cent of gross sales to do business, and an article costing $1.00 is sold for $1.25, what is the loss?

257. If the proper amount of syrup for a glass of soda water costs three-fourths of a cent and the boy puts in 15 per cent more than he should, what is the loss on 200 glasses?

258. If a druggist should make 60 per cent on gross sales by selling a dozen bottles of perfume at $1.50 each, what per cent profit would this be basing it on the cost price?

259. If a druggist should make 60 per cent on cost price by selling a dozen bottles of perfume at $1.50 each, what would be his per cent profit if one bottle was accidentally broken?

260. If rent is $75.00 a month, the salaries of the proprietor and clerks $250.00, other expenses $25.00, the profit on goods sold $33\frac{1}{3}$ per cent, what must be the amount of goods sold so that the proprietor will come out even at the end of the month?

261. If sugar costs $0.08 a lb., gas cost $1.00 per 1000 cubic feet, and flavoring costs $0.64 a pint, how much will one gallon of the syrup cost if 5 lbs. of sugar, 15 cubic feet of gas, and 2 ozs. of flavoring are used? If 2 ozs. of this syrup with 8 ozs. of carbonated water costing $.05 a gallon are used for one glass of soda water, and the clerk's salary is $10.00 a week, how many glasses at 5 cents a glass must be sold in a week to net the proprietor $50.00?

262. Total sales during 1905	$25,107.70
Goods bought in 1905	15,088.26
Inventory Jan. 1, 1905	13,816.38
Inventory Jan. 1, 1906	15,567.82
Cost of goods sold in 1905	13,336.82
Total expense including salaries	6,000.00

What is the gross profit per cent and the net profit per cent?

263. Cost of stock Sept. 1, 1904	$1,159.62
Inventory Sept. 1, 1905	1,398.35
Goods bought in the year	3,750.16
Total sales	5,890.93
Expenses including salaries	1,155.83

What is the per cent of gross profits and of net profits?

264. Inventory	$5,479.11
Inventory one year later	6,311.80
Sales	16,028.41
Purchases	11,081.89
Expenses	4,011.59

What is the per cent of gross and of net profit?

265. Fill in the blanks below.

Cash received from sales and book accounts	$10,300.96
Book accounts beginning of the year	104.39
Book accounts end of the year	163.39
Difference in book accounts	
Net sales for the year	
Inventory beginning of the year	2,863.85
Purchases during the year	6,636.62
Total cost of merchandise	
Inventory end of the year	3,437.08
Net cost of merchandise sold	
Gross profits	
Expenses	3,038.05
Net profits	
Per cent gross profit	
Per cent net profit	

ALLIGATION

Alligation is made use of in pharmacy to determine in what proportions or amounts different agents must be mixed in order to produce certain desired results. If we have a drug of a certain per cent strength and wish to mix it with the same kind of a drug of a different per cent to make a mixture of a desired intermediate strength, we place the two given per cents in a column and the desired per cent at the left with a perpendicular line between. The two given per cents are linked together. The difference between the desired per cent and the given per cent is written opposite the per cent with which that given per cent is linked. These differences represent the proportions to be used. If several per cents are given, one per cent lower than the desired per cent must always be linked with one higher. When more than three per cents are given, there will be two or more ways of linking them and the same number of correct answers possible. If per cents by weight are used, the proportions will be by weight. If per cents by volume are used, the proportions will be by volume.

If it is desired to make a given amount of such a mixture, these proportions are added and the sum divided into the amount of mixture to be made. Each proportion is multiplied by the quotient and the product is the amount of that sample to be taken.

Example. Having three samples of cinchona containing respectively 3, 6, and 8 per cent of quinine, how much of each sample must be taken to make a mixture of 100 Gms. containing 5 per cent of quinine?

Solution.

$$5\left|\begin{array}{l}\left.\begin{array}{l}3\\6\end{array}\right]\\8\end{array}\right]\begin{array}{l}\\ \\ \\ \end{array}\right]\quad\begin{array}{lr}1+3= & 4 \text{ parts of the 3 per cent;}\\ 2 & 2 \text{ parts of the 6 per cent;}\\ 2 & \underline{2} \text{ parts of the 8 per cent;}\\ & 8 \text{ parts of the mixture containing 5 per cent.}\end{array}$$

100÷8=12.5. Multiply each proportion by 12.5 and the products are the amounts to be taken.

$4\times 12.5=50$ Gms. of the 3 per cent;
$2\times 12.5=25$ Gms. of the 6 per cent;
$2\times 12.5=25$ Gms. of the 8 per cent.

Having a given amount of a substance of a certain per cent strength, it is sometimes desired to know how much of a substance of another per cent strength must be added to the given amount to convert it into a mixture of a desired per cent.

Example. Having 125 Gms. of opium containing 9 per cent of morphine, how much opium containing 12.5 per cent of morphine must be added to it to make a mixture containing 10 per cent?

Solution.

$$10\left|\begin{matrix}9\\12.5\end{matrix}\right]\begin{matrix}2.5\\1\end{matrix}\quad\text{or}\quad\begin{matrix}1\\\frac{1}{2.5}\end{matrix}\quad\begin{matrix}1\times125=125\text{ Gms. of the 9 per cent;}\\\frac{1}{2.5}\times125=\ \ 50\text{ Gms. of the 12.5 per cent.}\end{matrix}$$

For every 2.5 Gms. of the 9 per cent sample we must use 1 Gm. of the 12.5 per cent sample, or for every 1 Gm. of the 9 per cent sample we must use $\frac{1}{2.5}$ Gm. of the 12.5 per cent sample. For 125 Gms. of the 9 per cent. sample we must use $125\times\frac{1}{2.5}$ which is 50 Gms. of the 12.5 per cent sample.

If specific gravities are given instead of per cents, the example is worked in the same way, but the proportions found are always proportions by volume.

EXAMPLES

266. In what proportion must cinchona containing 4 per cent and cinchona containing 7 per cent quinine be mixed to make a mixture containing 5 per cent quinine?

267. Give the different proportions in which five samples of scammony containing 55, 64, 73, 81 and 90 per cents of resin can be mixed to make a mixture of 75 per cent.

268. How many Gms. of 31.9 per cent hydrochloric acid must be mixed with 5 per cent hydrochloric acid to make 1 Kg. of 10 per cent acid?

269. How many lbs. of 98 per cent sulphuric acid must be added to 1 lb. of 10 per cent acid to make a 20 per cent acid?

270. How many Gms. of sodium chloride must be added to 500 Gms. of a 0.6 per cent solution to make it into an 0.85 per cent solution?

271. How much stronger ammonia U. S. P. and how much water are necessary to make 5 pts. of 10 per cent ammonia having a sp. gr. of 0.96?

272. Having 500 Gms. of alcohol of 75 per cent by weight, how much water must be added to make it all into 25 per cent?

273. In what proportion must alcohol sp. gr. 0.82 and alcohol sp. gr. 0.986 be mixed to produce alcohol sp. gr. 0.92?

274. How many Cc. of water must be added to 200 Cc. of nitric acid sp. gr. 1.4027 to make it into acid of sp. gr. 1.0544?

275. How many fl. ozs. of hydrochloric acid 31.9 per cent and sp. gr. 1.1581 must be added to 10 fl. ozs. of hydrochloric acid 5 per cent and sp. gr. 1.0250 to make a 10 per cent acid of 1.0492 sp. gr.?

276. Having some recovered alcohol of 77 per cent by vol. and 0.8655 sp. gr., how many Cc. of it must be used with water to make 1000 Cc. of menstruum for making fluidextract of gentian which calls for equal volumes of official alcohol and water? (For per cent and sp. gr. of this menstruum see U. S. P. under Diluted Alcohol.)

277. Having recovered alcohol of 45 per cent by vol. of absolute alcohol, approximately how many fl. ozs. of this recovered alcohol and of official alcohol must be used to make ½ gal. of menstruum for fluidextract of henbane which calls for a mixture of official alcohol and water in the proportion of 600 to 300 by vol., no allowance being made for contraction?

278. Having 5 lbs. of cinchona 7 per cent quinine, 7 lbs. cinchona 8 per cent quinine, how many lbs. cinchona 3 per cent quinine are required to make a mixture of 5 per cent?

279. Having 1 lb. of extract of opium of 23 per cent morphine, how many ozs. of sugar of milk must be used to reduce it to 20 per cent morphine?

280. Wishing to make 5 lbs. of a 5 per cent solution of a salt, how much salt and how much of a 2 per cent solution must be mixed together to produce it?

281. In what proportion should glycerin sp. gr. 1.25 and water be mixed to make a mixture having a sp. gr. of 1.13?

282. Having 10 fl. ozs. of nitric acid 85 per cent (by wt.) and 1.46 sp. gr.; 12 fl. ozs. of nitric acid 75 per cent and 1.43 sp. gr.; 5 fl. ozs. of nitric acid 50 per cent and 1.30 sp. gr.; how many fl. ozs. of nitric acid 5 per cent and 1.02 sp. gr. should be used to make it all into acid of 40 per cent? What is the sp. gr. of the finished product?

BALANCES, WEIGHTS, AND MEASURES

These are illustrated and described in almost every catalogue of pharmaceutical apparatus and but few comments are necessary here. Balances when first purchased should be tested for accuracy and sensitiveness, and frequently retested. A prescription balance should be sensitive to one-thirtieth of a grain, while a balance made to carry not more than one-half pound should be sensitive to one-half grain. Balances are of many forms, but they can generally be put into one of the following classes: 1. Spiral spring. 2. Single beam, equal arm. 3. Single beam, unequal arm. 4. Compound lever. 5. Torsion.

The balances used in pharmacy are generally single beam equal arm, compound lever, or torsion. In the single beam the fulcrum or point of suspension should be a little above the center of gravity. If the two coincide the beam will stay in any position in which it is placed; if the center of gravity is above the fulcrum the beam will tend to turn over. The nearer the center of gravity approaches the edge of the fulcrum the more accurate and delicate will it be, but slower to oscillate and slower to weigh on. The knife edges are generally made of hardened steel, but these are liable to rust and corrode and in the better balances the knife edges and plates are made of agate. Scale pans should be made of solid nickel, hard rubber, or some substance that is not easily tarnished or corroded.

In the compound lever balance, there is a series of levers acting on one another. This balance is not as sensitive as the single beam and is intended for weighing heavier amounts.

In the torsion balance there are no knife edges. The beam is fastened at right angles to a thin steel band which is supported on two poles and is under high tension. The raising or lowering of one end of the beam causes a twisting of this band and the band of course tends to return to its original position.

Due care should be taken of any balance, particularly a delicate one. It should be placed on a solid level support where it will not have to be moved, will not be exposed to dust, moisture or acid vapors. It should never be overloaded, it should not be left on its knife edges or to swing when not in use, and weights should not be left on the pan.

Weights are generally made of iron, brass, aluminum, or platinum. Brass is used for the larger prescription weights and aluminum or platinum for the smaller ones; the first is liable to become tarnished or corroded and if they are frequently cleaned they become light weight. Aluminum and platinum resist corrosion but if touched by the hands they become soiled and too heavy; they should be handled with forceps. Weights should be frequently tested for accuracy. Reports of sealers of weights and measures show that too much emphasis cannot be placed on making sure that balances, weights, and measures are accurate.

Glass graduates measuring with a fair degree of accuracy can now be obtained. When only a few minims of a liquid are wanted, the minim pipette is more accurate than the graduate. In pouring a liquid from a bottle, the bottle should be held so that the liquid will run from the back part of the mouth. In this way the soiling of the label by having some of the liquid run down the side is avoided.

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THEORETICAL PHARMACY

DEFINITIONS

The work of the student in pharmacy is embraced in three divisions of science—pharmacy, chemistry, and materia medica—each of which is subdivided and merges into the other. No person can be an efficient pharmacist without a good working knowledge of all. To be an all-around good pharmacist, he must have both practical and theoretical training.

Pharmacy treats of the preparation and dispensing of medicines. In order to prepare them properly, it is necessary to have a knowledge of what constitutes good drugs, a knowledge of methods of testing for purity, of identifying, of estimating, and of preserving them. In order to dispense properly, it is necessary to have a knowledge of their physical and chemical properties, incompatibilities, and doses.

History. The use of medicine dates back as far as history goes. The earliest prescription of which we know is supposed to have been written about 3500 B. C. In early times the physician and pharmacist were one. At one time in England, pharmacy and the grocery business were connected but distinct from that of the physician. About the middle of the sixteenth century, Parliament passed a law allowing pharmacists to practice medicine under certain conditions. Perhaps the present tendency of pharmacists to practice medicine is partly hereditary. For a time previous to 1615, the sale of drugs was carried on by the guild of grocers from whom by law Parliament separated the apothecaries and established the Society of the Art and Mystery of Apothecaries. The troubles of the apothecary of that time seem to be quite similar to those of the present-day pharmacist.*

It is customary to divide pharmacy into theoretical and practical. **Theoretical** pharmacy treats of the principles involved in the preparation and dispensing of medicine, and **practical** pharmacy treats of the application of these principles. **Galenical** pharmacy is a term applied to those preparations in which chemical reactions do not occur, as in powdered drugs, simple solutions and mixtures. This word is derived from Galen, a physician who lived the latter part of the second century and whose materia medica consisted almost wholly of vegetable drugs.

A **pharmacopœia** is a book prepared by some recognized authority and contains a list of medicinal substances and preparations, giving descriptions, tests for identification, for purity, for strength, and methods of preparing for administration. Probably the first book worthy of being called a pharmacopœia was written by Valerius Cordus and published by the city of Nuremb~~u~~erg in 1546. The London Pharmacopœia appeared in 1618, but the first national pharmacopœia was that of France, which was published in 1818 and was followed two years later by the United States Pharmacopœia. There are now about twenty national pharmacopœias. A brief history of the U. S. P. is given in the Historical Introduction in the front part of that book.

An international pharmacopœia is considered desirable by some persons, but such a book is not likely to be produced soon. What amounts to practically the same thing is to have the revisers of the various pharmacopœias agree as to standards, and this is being done.

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* For an interesting history of pharmacy, see Chronicles of Pharmacy, by A. C. Wooton, pub. by Macmillan & Co.

While in most countries the pharmacopœia is issued and revised under the direction of the government of that country, in the United States it is issued and revised by a convention called for that purpose. This convention is made up of delegates. Each incorporated medical college, incorporated medical association, incorporated pharmaceutical college, incorporated pharmaceutical association, if they have been incorporated for five years previous to the time of the meeting, may send three delegates. In addition to delegates from these bodies the following were represented at the last convention: The Army, Navy, Marine Hospital Service, U. S. Department of Agriculture, American Pharmaceutical Association, American Medical Association, American Chemical Society, Association of Official Agricultural Chemists, National Food and Dairy Association, National Wholesale Druggists' Association, and National Dental Association. This convention meets in Washington every ten years, having last met in May, 1910. It outlines in general the work and policies to be followed in the revision, but delegates the actual work to a Committee of Revision which is chosen from its own members.

Arrangement of the Pharmacopœia. 1. In the U. S. Pharmacopœia the drugs are arranged in alphabetical order of the Latin names. The Latin name is most frequently either the generic or specific name in case of a vegetable drug, although it may be some other name by which the drug has long been known. 2. The Latin name is followed by the English name. 3. This is sometimes followed by a synonym. 4. The official definition gives the part of the plant used and the botanical name in case of vegetable drugs, and the chemical formula in case of chemicals. It frequently includes the "purity rubric" which is the standard of strength required. 5. In the official description is given the physical properties, tests for identification, tests for impurities, and method of estimation. 6. Lastly the average dose is given. The usual maximum dose would be of much more service as both the pharmacist and the physician want to know the limit beyond which it is generally not advisable to go.

The **National Formulary** is a book containing formulas which, though of considerable importance, are not incorporated in the Pharmacopœia. In addition to formulas, the N. F. now gives descriptions and tests of some less important drugs and chemicals. This book is revised and controlled by the American Pharmaceutical Association, which is not the same body that revises and issues the U. S. P. The first edition of the N. F. was published in 1888; the second in 1896; the third in 1906; the present edition in 1916. Part II, containing descriptions and tests of drugs and chemicals, has not appeared in previous editions, nor has Part III, which gives special tests and reagents. A chapter on sterilization is also new.

The Pharmacopœia and National Formulary were made the official standards for the Food and Drug Law passed by Congress in 1906. This has brought both books into greater prominence, and has necessitated greater care in the standards adopted and the methods of estimation.

A **dispensatory** is a commentary on a pharmacopœia. Besides including all that is given in the Pharmacopœia it discusses practically all drugs used in medicine, giving their action and uses. The three books in the United States called dispensatories are United States Dispensatory, National Standard Dispensatory, and King's American Dispensatory.

Pharmaceutical Jurisprudence has been defined as "The application of the principles of law to conditions developed by the practice of pharmacy." The pharmacy laws which have been enacted by every State, and later the Federal and State Food and Drug Laws, have greatly limited the practice of pharmacy, and have done much good in the way of producing efficient pharmacists and rendering drugs and preparations more uniform in strength.

COMMINUTION

Comminution is the reduction of any substance to small particles or a powder. The object of this treatment may be to aid drying or preservation, to aid extraction or solution, or to facilitate handling. The several processes used are slicing, contusing, rasping, grinding, powdering, triturating, and levigating. Except on a small scale the retailer is not called on to perform any of these.

Slicing is limited to the cutting of fleshy or tuberous parts of plants for the purpose of drying, as in case of Indian turnip, colchicum root, or squills, or to aid extraction, as in vanilla. The more common instruments used are knives, shears, tobacco cutters, or hash knives.

Contusion is pounding or bruising, and is generally applied to tough, fibrous drugs, or to fresh plants. The drug is reduced to a coarse powder or mass only. For dry drugs a deep iron mortar with a flaring edge is the best, and it should rest firmly on a solid base. A heavy cloth or rubber cover with a hole for the pestle is sometimes used to prevent the escape of dust. A Wedgwood mortar should be used if the drug is fresh, so that the product will not become colored or contaminated with iron. The operation will be completed more quickly if only a small amount of drug is placed in the mortar at a time.

Grinding or **powdering** is the reduction of a substance to a powder by friction and pressure. There is no distinct line between the two, but we often refer to a substance in coarse particles as having been ground or granulated, and that in a fine condition as having been powdered. In powdering anything the fine particles should be sifted out occasionally so that they will not surround and protect the coarser ones. After a substance has been powdered, all of the siftings should be thoroughly mixed, because some parts of the drug are more easily powdered than others, and may contain more or less active matter.

Mills. Grinding or powdering vegetable drugs is done in mills, of which there are many forms and modifications, depending upon the fineness of product desired, and on the nature of the drug. A **pebble mill** is good if the drug is resinous or liable to cake. It consists of a cylinder revolving on its longitudinal axis and containing different sized balls of flint, iron, or porcelain. These grind by friction against one another and against the cylinder, having a sliding as well as rolling motion.

The term **chaser mill** is applied to those in which two large wheels, generally of stone and resting on their edges, are fastened on a short axle, and made to revolve around a central point in the axle—one wheel chasing around after the other, the two running on the flat surface of a third stone. Both a crushing and a rubbing effect is produced.

A **buhrstone mill** is one in which corrugated surfaces of two plates run together, one plate stationary and the other revolving, or both revolving but in opposite directions, the plates being in a horizontal or vertical position.

In the Bogardus **eccentric mill** the grinding surfaces run in the same direction, but the axis about which one runs is not in line with the axis of the other. This mill can be run at a high rate of speed and causes a rolling, grinding motion which quickly reduces the material to a fine powder.

Meade's **disintegrator** consists of a disk on the side of which, near the edge, are fastened steel projections. The disk revolves very rapidly, the projections run close to a corrugated surface and beat the drug against the corrugations until it is sufficiently fine to pass through the openings.

In the retail store a small hand mill is sometimes convenient. After grinding a drug, the mill should be thoroughly cleaned. This can often be done by running sawdust through it, but if the drug has caked it may be necessary to take the grinding surfaces apart and wash with warm water. In grinding a drug, time and labor can be saved by reducing it to a coarse powder, then to a finer one, but not to the desired degree of fineness the first time it is passed through the mill.

Trituration is the reduction of a solid to a fine powder by rubbing in a mortar. Crystals and chemicals can generally be quite readily powdered, but with certain compounds it is easier if a volatile solvent is used in just sufficient amount to dampen it, as in powdering camphor with alcohol or ether. Some drugs give trouble by becoming electrified, as resin or acetanilid; dampening with a volatile liquid overcomes the difficulty. Drugs which are tough may best be powdered by the addition of some gritty solid, as sugar of milk in making Dover's powder, or sand in tincture of lactucarium.

Mortars are most commonly made of earthenware known as Wedgwood, sometimes of porcelain or glass. Glass is objectionable because it is so smooth and easily broken. Wedgwood mortars after long usage become smooth and can be roughened by triturating with sharp sand. The solid or one-piece pestle is the most satisfactory, but breaks easily on being dropped. With the wooden handle Wedgwood-tipped pestle the handle becomes loose and the cementing material is likely to get into the drug being triturated. The convex surface of the head of the pestle should have a slightly smaller curvature than that of the concave surface of the mortar.

Levigation is the powdering of a substance in the presence of a liquid in which it is not soluble. Some chemicals can be more finely and easily powdered in this way. An example is found in the method of making ointment of yellow oxide of mercury. Levigation is carried on in a mortar and porphyrization is practically the same thing carried on with a slab and muller.

Precipitation is the rendering insoluble of anything in solution. This may be done by changing the solvent, as adding water to spirit of camphor; by adding another solid without causing chemical change (salting out), as adding sodium chloride to a solution of pepsin; by chemical action and the formation of a new compound. The object of precipitation may be to purify the material, to get it into a finer powder, or to get a new compound. If chemical reaction takes place and a dense heavy precipitate is desired, the solutions of agents reacting should be hot and concentrated and if a light precipitate is wanted the solutions should be cold and dilute. The best form of a precipitating jar is one in which the diameter at the bottom is greater than that at the top; the precipitate in settling does not rest on the sides of the jar. The liquid from which the precipitate has settled is called the supernatant liquid.

Granulation of chemicals is generally effected by evaporating a solution and stirring while the solid is separating. Sometimes a powder is dampened with alcohol or alcohol and water and passed through a coarse sieve. A metal may be granulated by melting and pouring into water or by heating to near its melting-point and then rubbing it. Sometimes we speak of granulated vegetable drugs, meaning coarsely ground powders.

Elutriation is a method of separating coarse particles from fine ones. The powder is mixed with a liquid in which it is insoluble, the coarser particles, being heavier, are allowed to settle. The liquid holding the finer powder in suspension is decanted and allowed to rest and again decanted and allowed to stand, thus separating the powder into any number of lots of varying fineness. If the damp powder obtained in this way is allowed to drop from a funnel-shaped vessel so as to make masses like drop chalk, it is called trochiscation.

Separation of fine from coarse particles is generally effected by sifting. Powders should not be forced through a sieve. The sieve is known by the number of the meshes to the linear inch. One having eighty meshes to the linear inch is known as a No. 80 sieve, and the powder which passes through it as a No. 80 powder. The U. S. P. specifies the maximum size of the particles passing through a sieve. Copper wire is generally used in making a sieve, and it should have the correct gauge, as a coarse wire would make the openings too small and a fine wire would make them too large. Of a powder of any given number, not more than 20 per cent of it should pass through a sieve having ten meshes more to the inch. A No. 80 or 100 sieve is about as fine as is generally used, and when a finer powder is wanted it is passed through a bolting cloth.

SOLUTION

Definition. Solution may be defined as the molecular subdivision of a substance by means of another substance, the result being a homogeneous liquid. In dissolving a solid in a liquid the cohesion of the molecules is overcome by adhesion. The product of solution is called solution; the agent producing solution, the solvent; the agent dissolved the solute.

Kinds. It is common to speak of simple solution and of chemical solution. In simple solution the agent dissolved and the solvent do not lose their chemical properties, and can be separated into the same conditions as they were before being dissolved, as salt in water. By chemical solution (sometimes called complex solution) is meant a solution in which chemical reaction takes place; the substance dissolved and the solvent form a new compound, as iron dissolved in hydrochloric acid gives chloride of iron.

A solution may be made by mixing a solid (as sugar), a liquid (as glycerin), or a gas (as hydrochloric acid), with a liquid (as water). Or it may be made by mixing two solids together (as menthol and camphor), but in this case chemical reaction may take place.

A saturated solution of anything is one in which no more of that substance will dissolve in the liquid, the adhesion of the molecules of the solvent for the solute being satisfied. Though the liquid is saturated with one substance it is not necessarily saturated for others.

A supersaturated solution is one in which, under certain conditions, the liquid is made to hold in solution more of the substance than it will do ordinarily. A hot saturated solution of certain salts, as magnesium sulphate, if allowed to cool without any disturbance, may retain the salt in solution at ordinary temperature, but if it is disturbed the salt will at once crystallize out, and in crystallizing quickly heat is imparted to the mixture.

Solvents. The more common solvents are water, glycerin, alcohol, ether, chloroform, petroleum ether, benzol, carbon disulphide and carbon tetrachloride. There are some compounds which are not soluble in any known solvents without chemical change, but most compounds are more or less soluble. When we speak of anything being soluble, if no solvent is mentioned, water is referred to. In prescription work a knowledge of the approximate solubility of common substances is essential, as many of the incompatibilities are due to insolubility.

In general, water is a good solvent for many salts and compounds, either inorganic or organic, salts of alkaloids, acids, and alkalies. Glycerin will dissolve quite a number of things which water will, and will precipitate but few things from aqueous solution. It is a solvent for many metallic oxides and deliquescent salts. Alcohol dissolves a few inorganic salts, many organic salts and compounds, alkaloids, and volatile oils. Ether, petroleum ether, benzol, chloroform, and carbon disulphide are somewhat similar to one another, and dissolve but very few inorganic compounds, some organic ones, resins, and free alkaloids. Acids and alkalies often affect solution, but generally with chemical action. Citrates and tartrates in water aid the solution of many salts not soluble in water.

Aids to solution. 1. Solution is aided by having the solid in the form of a fine powder, because the surface exposed to the solvent is much greater. Scale salts of iron are better not powdered, as they are liable to gum up and make a mass which dissolves slowly. 2. Agitation aids solution by bringing a less saturated liquid in contact with the substance. 3. Heat generally aids solution, perhaps to some extent by separating the molecules farther apart, and by keeping the liquid in motion. Heat is not always allowable, as it may injure the active agent. A few compounds, as some of the calcium salts, are less soluble in hot water than in cold. Sodium sulphate is most soluble at a temperature of about 34° C.

Circulatory solution or displacement is performed by suspending the substance to be extracted in a bag or basket in the upper part of the solvent. As the matter dissolves out, the liquid becomes heavier, sinks to the bottom, and less saturated liquid takes its place. This process is of particular service in dissolving such agents as iodine, acacia, and camphor, and in making infusions.

Rapidity of solution varies with the agents and with the solvents. A compound may be very soluble but dissolve slowly, or it may dissolve quickly but not be very soluble. The presence of one compound in solution may have an effect on the solubility of another. Potassium iodide greatly increases the solubility of iodine in water. Adding sodium chloride in sufficient amount to a solution of pepsin throws the pepsin out of solution.

In making a solution the temperature may rise or fall. When chemical reaction takes place it will almost invariably rise. In dissolving a salt from which the water of crystallization has been driven off, the temperature will rise on account of the salt combining with water of crystallization. In dissolving a very quickly soluble crystalline salt in water the temperature falls noticeably, due to the change of active heat to latent heat, the heat being taken up to keep the solid in liquid form. A mixture of ice and salt is used as a freezing mixture because, as both solids change to liquids, much heat is taken up.

Stock Solutions. Some chemicals dissolve slowly in water. At the prescription counter where frequent calls are made for such chemicals, much time and trouble can be saved by keeping these in concentrated solutions. Stock solutions are generally made up so that a fluid dram or a fluid ounce contains a certain number of grains of the chemical, e.g., one fluid ounce of stock solution of mercuric chloride may contain 32 grains of the salt; if a prescription calls for one grain of mercuric chloride, 15 minims of the solution would be used. Some of the salts most commonly kept in stock solution are mercuric chloride, potassium chlorate, potassium acetate, potassium iodide, potassium bromide, ammonium chloride, magnesium sulphate, and strychnine sulphate; the list varies in different stores, depending upon the frequency of the call for them. Some of these solutions do not keep well and may have to be made up frequently in small amounts. Sometimes a preservative can be added, as sodium chloride to mercuric chloride solution, or alcohol to alkaloidal solutions.

Volume. The volume of a solution is less than the sum of the volumes of the ingredients but greater than the volume of the solvent. Seventy-five Gms. of sugar increase the volume of the liquid about 50 mils; 40 Gms. of potassium iodide, about 12 mils; 10 Gms. of camphor in alcohol, about 10 mils. A solid dissolved in water generally increases the specific gravity, raises the boiling-point, and lowers the freezing-point. Two liquids on being mixed sometimes contract, as alcohol and water.

The **solubility** of a solid may be determined by agitating the solvent with an excess of the solid until the latter is saturated, filtering, and rejecting the first part of the filtrate, then catching a weighed amount of the filtrate and evaporating it in a tared dish. From the weight of the solution subtract the weight of the residue and the difference is the weight of water in which the solid was dissolved. Filter paper sometimes takes some of the solid out of solution, consequently the above direction to reject the first part of the filtrate.

When it is desired to determine the solubility of a solid in a boiling solvent, Dr. Charles Rice's lysimeter gives good results. It consists of a tube having a constriction near one end and having a ground-glass stopper for each end. Into the end having the constriction is put a plug of cotton. The solid in excess is put into the solvent and boiled until the liquid is saturated. Into the boiling liquid is put the end of the lysimeter carrying the cotton so that the liquid will filter through the cotton into the tube. The tube is raised and lowered several times so as to get it and the liquid in it up to the boiling-point of the liquid. While the tube is still in the liquid the stopper is inserted into the upper end, the tube withdrawn, the cotton removed, the tube wiped off and the other stopper inserted. When cool the tube and contents are weighed, the contents poured into a tared dish and the tube thoroughly washed with some pure solvent, the liquid evaporated and the residue weighed.

Hygroscopic. If a substance absorbs moisture from the air it is said to be hygroscopic, as powdered opium. If it absorbs enough to liquefy it, it is said to be deliquescent, as potassium acetate. If a substance is free from water, particularly from water of crystallization, it is said to be anhydrous, as bismuth subnitrate.

Dialysis is the separation of crystalloids from colloids by osmosis. Osmosis is the diffusion of liquids through organic membranes, as animal bladder or parchment paper. If a bladder is filled with water, no drops of water will appear on the outside even when the bladder is tied and subjected to pressure. But if the bladder is put into one liquid or solution and another miscible liquid or solution is placed in the bladder, the liquids will gradually diffuse. Solids which are crystallizable, or resemble crystallizable substances in solution, will pass through the membrane or septum more or less rapidly, and are called crystalloids. Substances which are not crystallizable do not pass through the membrane, or but very slowly, and are called colloids. A dialyzer may be made by cutting off the bottom of a bottle or beaker and tying a piece of parchment paper over it and then suspending it in contact with water in a larger vessel. Dialysis is sometimes used to separate poisons from other organic matter in cases of toxicology, or in making solution of dialyzed iron

COLLOIDAL SUSPENSION

Under certain conditions some metals and non-metals, and some insoluble metallic salts may be mixed with water to make what has been thought to be solutions. The particles of solid matter were so small that they could not be seen with the highest magnifying microscope. But with the ultra microscope the reflected light from these particles may be seen. It has been suggested that they approach the molecular size. These liquids come in between true solutions and coarse suspensions. It is more proper to speak of them as colloidal suspensions than colloidal solutions.

Colloidal suspensions may be made in different ways. 1. By the electric current. If two wires of the metal to be made into the suspension are dipped into absolutely pure water and a strong electric current passed through, making an arc in the water, the metal is torn from the cathode in a very fine subdivision, the water becomes colored, and we have a colloidal suspension. The amperage and voltage of the current make some difference. The fineness of the particles also causes some variation in color. 2. By dialysis. 3. By precipitation or reduction of the substance, usually in the presence of some organic matter, which is naturally of a colloidal nature, as peptone, casein, vitellin, gelatin, various other albuminous substances, starch, gums, and mucilages, particularly sodium arabate (made from acacia). While some colloidal suspensions of metals can be made without the presence of these naturally colloidal organic compounds, they are not stable, but are rendered much more permanent by the presence of these organic substances.

Colloidal suspensions are often not precipitated by the chemicals that ordinarily cause precipitation of the metal, but they should not be given with other chemicals. These suspensions frequently have a catalytic action, resembling that of the enzymes.

A large number of colloidal suspensions have been made, but the ones most commonly used in medicine are bismuth oxide (Bismon), calomel (Calomelol), metallic mercury (Hyrgol), silver oxide (Cargentos), metallic silver (Collargol), and metallic copper (Cuprol).

EXTRACTION AND PERCOLATION

Extraction is a process of dissolving out the soluble constituents of a mixture, leaving behind the insoluble matter. There are several ways of accomplishing this—maceration, digestion, circulatory solution, percolation, repercolation, and continuous percolation. **Maceration** is the soaking of a substance in a liquid, and is often a preparatory step for other processes. It is essential in making strong extracts of vegetable drugs, as time is required for the liquid to permeate the dried particles. Digestion is the same as maceration except that it is carried on at a temperature higher than that of the room, from a gentle to a boiling heat. If the digestion is to be carried on at a high temperature for some time a reflux condenser is used to prevent the loss of menstruum and avoid concentration of the liquid.

Percolation is the extraction of soluble principles from a mixture of soluble and insoluble matter in a percolator or suitable container by passing a liquid through it. The liquid used is called the menstruum; the liquid after passing through the drug is called the percolate; the exhausted drug is called the marc; the vessel holding the drug, the percolator; the solid matter dissolved by the menstruum is called the extractive, although this term is often given to the inert soluble matter alone. As the liquid passes downward, it becomes more nearly saturated with the soluble constituents; the more saturated layers of menstruum are displaced by less saturated ones. Under the name of leaching or lixiviation this process has been used for many years. In the early part of the nineteenth century the process was applied to the extraction of drugs, and it became official in the 1840 revision of the U. S. P., but was not generally used until about twenty years later. This is an important process, being used in several classes of preparations, and is discussed at some length in the U. S. P., pages 173–176 and 613–615.

Percolators vary in shape from a cylinder to a funnel. Small ones are made of glass and large ones of tinned iron or tinned copper or of earthen ware. Metal should not be used if the menstruum contains an acid. If the menstruum is fairly strong alcohol, and the drug is not liable to swell, a cylindrical percolator can be used, but if the drug swells, as is likely to be the case when the menstruum is water or weak alcohol, a more conical percolator is preferred so that the drug as it swells can push upwards and not become so tightly packed that the menstruum will not pass through it. In a funnel-shaped percolator the menstruum passing directly downwards will pass through a very short column of drug situated near the periphery, soon striking the side of the percolator, down which it runs without extracting the drug. The liquid which passes through the drug near the center of the percolator will pass through a longer column of drug and consequently will be more nearly saturated. If the proportion of menstruum to drug is large, as in making tinctures, a more conical percolator can be used than where the proportion is small, as in making fluidextracts. A slightly conical nearly cylindrical percolator is recommended where only a few pounds of drug are to be extracted.

Percolators must have some device by which the flow of liquid can be regulated. Large percolators are best made with a stop-cock. In small ones a plain sprinkler top for a toilet water bottle answers well. Or, a cork perforated by a glass tube to which a short piece of rubber tubing with a Hofmann clamp is attached may be used. Less satisfactory is a longer tube without the clamp, the flow being regulated by raising or lowering the free end. It is sometimes convenient to have the receiver graduated.

Squibb's well tube percolator consists of an earthen jar, on the inside of the bottom of which is fitted a piece of felt. The end of the well tube rests on the felt and the drug is packed around the tube. The menstruum passes down through the drug and felt and rises in the well tube from which it is siphoned off. The rate of flow is regulated by raising or lowering the siphon. To prevent the siphon from emptying itself the outer end is bent up so that the open end is three-fourths to one inch above the bend.

Pressure percolators are used in some laboratories, particularly when repercolation is resorted to. Anderson's pressure percolator consists of a tin-lined copper cylinder fitted with a metallic head. The head is made of two metallic plates between which is a rubber ring that just fits into the cylinder. When these two plates are drawn together by a bolt the rubber is forced against the sides of the percolator, making a tight joint. This head is perforated by a tube to which is attached a long rubber tube for the admission of menstruum. The other end of the tube is attached to the reservoir containing the menstruum. By raising or lowering the reservoir with a rope and pulley the pressure is increased or lessened. Three or four of these percolators can be connected in series and used for repercolation.

If the menstruum is very volatile, as in making oleoresins, a specially designed percolator is desirable. The percolator should be tightly closed at the top and tightly connected with the receiving bottle. The upper part of the receiver should be connected with the upper part of the percolator by a tube to allow the air to pass from the latter to the former as percolation proceeds.

The directions for percolating are given in detail under fluidextracts, as care is required in making these preparations.

Repercolation or fractional percolation is the passing of partially saturated portions of percolate through fresh portions of drug. There are different methods of carrying this out, one of which is given under "Type Process C," on page 175 of the U. S. P.

Continuous percolation is the process by which a menstruum is used over and over again to extract the same drug until it is exhausted. There are a large number of forms of apparatus for this, one of the more common ones being the Soxhlet extraction tube. In this the lower end is connected with a flask and the upper end with an upright condenser. The volatile menstruum passes through the drug and through a small siphon-tube side-arm into the flask. Heat is applied to the flask, the liquid is volatilized and passes through another side-arm to the condenser, where it is condensed and falls back upon the drug and again commences its cycle. A small amount of liquid will extract a comparatively large amount of drug.

SEPARATION OF SOLIDS FROM LIQUIDS

In large laboratories a solid may be separated from a liquid or a liquid from a solid by means of a centrifugal machine. Such a machine is built on the principle that when a substance is whirled in a circle, centrigufal force tends to make the particles fly farther from the center, in the direction of the tangent of the circle. Centrifugal machines vary in structure with the object to be obtained. In some cases the cylinder is perforated so as to allow the water to escape. If the object is to separate a finely divided solid from a large volume of liquid, as solid matter from urine, the mixture is placed in a long, tapering container which is arranged so that the closed end will swing out when it is being revolved, and the solid, being heavier than the liquid, is deposited in the apex of the tube. A centrifuge is useful in breaking up an emulsion formed in analytical work.

Colation or straining is the separation of a solid from a liquid by passing through a coarse filtering medium as a sieve, a piece of cheesecloth, muslin, domestic, linen, flannel, or felt. It is used when only coarse particles are to be removed or where the liquid is too thick to pass through a filter paper. Flannel or felt will take out finer particles than the other media mentioned. The strainer may be held by a tenaculum, which is a frame with projecting brads or nails on which the cloth is hung.

Filtration is the same as straining except that the filtering medium is of finer texture and will remove smaller particles. Filter paper, cotton, asbestos, sand, charcoal, talc, kieselguhr, glass wool, and unglazed porcelain, are used as filtering mediums. Filter paper, which is unsized paper, is the most convenient, and can be obtained in varying degrees of thickness and porosity, suitable for different purposes. Only the white paper should be used, as the gray is impure and may give coloring or solid matter to the filtrate. A plain filter is one which is folded twice and lies flat against the sides of the funnel; it should be the only kind used if the precipitate is to be washed clean. A plaited filter is folded to make usually sixteen or thirty-two sectors or faces; the filter rests on the edges of the folds, forming channels between the paper and funnel, down which the filtered liquid may run. On account of these channels the liquid will pass through more rapidly. A filter paper should not extend above the sides of the funnel; it should be moistened with a liquid similar to that of the solution to be filtered; and the liquid should be poured against the side of the filter and not on the apex to avoid breaking the paper. Cotton in the neck of a funnel is convenient for clearing up prescriptions. Asbestos is used for filtering alkaline corrosive liquids, or in a Gooch crucible for taking out a very fine precipitate. Glass wool is used in filtering acid corrosive liquids. Talc and kieselguhr are used with a filter paper to take out particles which would otherwise pass through the filter. Unglazed earthen ware, as a Chamberland filter, is used largely to remove bacteria and microörganisms.

If the precipitate is very fine, and particularly if it is albuminous, it will sometimes clog the filter so that the liquid will not pass through. In such a case the funnel may be fitted to a flask by means of a tightly fitting stopper, and a partial vacuum produced by a suction pump attached to a hydrant. The pump is so arranged that water passing through it carries air from the flask. The filter paper must fit close to the funnel and it may be necessary to strengthen the apex of the filter by a perforated metallic cone or by a second filter. In upward filtration the liquid is made to pass from the lower to the upper side of the filter or strainer, so that the solid may drop away from the filter.

Funnels are most frequently made of glass, although for certain things metal or porcelain may be used. Care should be taken to get funnels with an angle of 60° if they are to be used with filter paper, as that is the angle of a plain filter when in a funnel. In place of a plain filter and smooth funnel a funnel with ribs on it may be used, or a filtering rack, which keeps the paper away from the funnel. Hot filtration is seldom necessary in pharmacy, but a hot-water bath made to be used with a funnel is sometimes convenient. Hot filtration is necessary in making culture mediums in bacteriology.

Clarification. Sometimes a liquid has suspended in it some solid matter which renders it turbid but which filtration will not remove. There are different methods of clarifying it. 1. Heating may do it by coagulating albuminous matter present and in this coagulum the solid particles become entangled. 2. Heat may render the liquid sufficiently thin so that the suspended matter will rise or settle. 3. If albumin is not present, it may be added in the form of a solution of egg albumin and then heat applied. 4. Milk may be used, particularly with acid liquids, the acid coagulating the casein. 5. Fermentation by forming alcohol and acid may clarify the liquid through the precipitation of pectin or albumins present. 6. Shaking with paper pulp sometimes clarifies the liquid. 7. Gelatin in shreds will clarify the liquid if due to tannin, the tannin combining with it. 8. Allowing the liquid to stand for some time will often effect the desired result.

Animal and vegetable charcoal, freshly percipitated aluminum hydroxide (alumina cream), and some silicates of aluminum have the property of removing solids from solution. On this account they are used to decolorize solutions of alkaloids, glucosides, sugar, etc. Sometimes they are objectionable because they remove active principles. To some extent they take out of solution alkaloids, glucosides, and other compounds, and for this reason charcoal is recommended in cases of poisoning by alkaloids. Animal charcoal is more absorbent than wood charcoal.

Separation of Liquids. Immiscible liquids (those which do not make homogeneous solutions when mixed), can be separated by a separatory funnel, which consists of a bulb terminating in a stem with a stop-cock in it. The mixture is poured into the funnel and when the heavier liquid has settled it is drawn off. In extracting a water solution with ether, chloroform or other immiscible liquid, an emulsion is sometimes made which is hard to break. Standing, gentle twirling, addition of alcohol, or the use of the centrifuge may break it, but it is better to avoid the formation if possible.

Detannating Liquids. Tinctures, wines, and other liquids are sometimes to be mixed with iron preparations, thereby making undesirable, black, inky mixtures. Tannic acid can be removed in several ways. Freshly prepared ferric hydroxide combines with tannic acid to make an insoluble tannate which can be filtered out. Ferric hydroxide is not good for wines or preparations containing acids other than tannic, because the iron is partially dissolved. In such case one part of powdered gelatin to two hundred and fifty of wine is best, the tannic acid combining with it. Fresh milk has been used for detannating wine, the casein making an insoluble compound with tannin, but this dilutes the wine and introduces matter which is not desirable.

HEAT

Heat has been defined as a force generated by molecular motion, or the manifestation of one form of molecular motion, or the force which overcomes molecular cohesion. It is assumed that all bodies have more or less molecular motion; the greater the motion, the greater will be the heat. The terms hot and cold are relative only. Heat causes substances to expand, overcoming the cohesion of molecules.

Active or sensible heat is that form of heat which can be measured by the expansion of bodies. **Latent heat** is heat that is apparently absorbed by a substance in changing from a solid to a liquid, or from a liquid to a gas—the heat that is required to keep a solid in liquid or a liquid in gaseous form. It is not measured by a thermometer. In melting ice the water remains at the same temperature until the ice is melted, although heat has been taken up. When ether is allowed to evaporate it produces cold which is due to taking up heat, the changing of active to latent heat.

The **principal sources** of heat are the sun, chemical action, mechanical force, and electricity. Electricity is in many ways the most convenient, the most easily regulated, and the most uniform heat, but, as yet, too expensive for general use. In the drug-store, heat is obtained chiefly by oxidation, in burning coal, gas, oil, alcohol, or gasoline; carbon and hydrogen combine with oxygen to make carbon dioxide and water. Illuminating gas, which can now be found in all but very small towns, is satisfactory. Illumination from burning oil or gas, or from the carbon-film electric light bulb, is due to the heating of carbon to an incandescent condition. In case of the blue flame of the Bunsen burner, there is a sufficient amount of oxygen mixed with the gas to enable the carbon completely to combine with oxygen, thus producing more oxidation and greater heat. Grain alcohol is expensive, but that of about 75 to 80 per cent is more economical than the stronger, as there is less lost in evaporation; denaturized alcohol can be used. Wood alcohol should not be used, as it is oxidized to formaldehyde and formic acid, which are harmful. Various forms of burners for the different fuels are described in catalogues.

The **amount** of heat which a substance can produce when oxidized or burned is measured in calories. A calorie is the amount of heat which is necessary to raise one kilogram of water from 0° C. to 1° C. If a given amount of a substance is burned, it will give a definite amount of heat regardless of how quickly or how slowly it burns. The value of coal and of food as producers of heat is estimated in calories.

Temperature is used to denote intensity; it is the intensity of heat referred to some arbitrary standard. Intensity depends upon the rapidity of combustion and is measured by a thermometer.

A **thermometer** is a capillary glass tube, sealed, with a bulb on one end, containing a liquid, usually alcohol or mercury. Alcohol is not good for measuring high temperatures, as it boils at about 78° C., but it is good for low temperatures, as it cannot be readily solidified. Mercury solidifies at −40° C. and boils at about 360° C. It is preferable for temperatures generally used in pharmacy, because it does not adhere to glass, and it does not form a meniscus on account of capillary attraction. Mercury expands or contracts about seven times as much as glass.

The three thermometer scales used are the Fahrenheit, centigrade and Réaumur, the latter not being used in the United States. The fixed points taken are the freezing- and boiling-points of water; 32° F., 0° C., or 0° R. is the freezing-point of water; 212° F., 100° C., or 80° R. is the boiling-point of water. To convert Fahrenheit into centigrade, subtract 32 from the number of Fahrenheit degrees and take $\frac{5}{9}$ of the remainder. $C. = (F. - 32)\frac{5}{9}$. To convert centigrade to Fahrenheit, get $\frac{9}{5}$ of the centigrade degrees and add 32 to it. $F. = \frac{9}{5}C. + 32$. Thermometers for registering as high as 550° C. are made of Jena resistance glass which has a high melting-point, and to prevent the boiling of mercury the tube is filled with carbon dioxide under pressure. The clinical thermometer is so made that the column of mercury will remain at the highest point to which it goes. Thermometers should be kept for a year or two before graduating in order to allow for the contraction of glass, which goes on slowly.

A **pyrometer** is an instrument for measuring high temperatures where thermometers cannot be used. It is generally made of metal whose melting-point is high.

A **thermostat** is an instrument for regulating the amount of heat. The thermostat used with gas regulates the amount of gas burned. It consists of a tube carrying a long bulb containing mercury, the bulb being in the oven whose temperature is to be regulated. By means of an inner tube reaching nearly to the mercury and connected with a side arm attached to the upper part of the thermostat, the gas enters the thermostat and through another side arm passes to the burner. As the oven becomes warm the mercury expands and slowly closes the end of the tube, cutting off the supply of gas. To prevent the gas from being entirely cut off there is a pin hole higher up in the tube, letting enough gas through to keep the pilot light going.

Regulation of Heat. In the application of heat in pharmaceutical operations it is often desirable to equalize or distribute heat. This can be done by asbestos pads, hot air or steam ovens, steam under pressure, or baths containing water, toluene, solutions of salts, glycerin, fixed oils, paraffin, or sand. When a temperature of not over 100° C. is desired, and this is about as high as can be safely used with organic matter, the water-bath is the best. A liquid in a dish on a boiling water-bath does not get to a temperature much above 95° C. The temperature of steam varies with the pressure; a pressure of 5 lbs. gives a temperature of about 109° C.; of 10 lbs., about 115.6° C.; of 15 lbs., about 121° C.; of 60 lbs., about 153° C. A saturated solution of sodium chloride gives a temperature of about 108° C.; of sodium nitrate, about 121° C.; of calcium nitrate, about 151° C.; of calcium chloride, about 179° C. These salt baths are often not satisfactory because the water evaporates and the salt separates. A bath of toluene gives a temperature of about 110° C., of glycerin, oil, or paraffin, about 200° to 250° C. Water-baths are often fitted so as to keep a constant level, fresh water coming in as water evaporates. To prevent loss of toluene, the bath is fitted with a long condensing tube.

Applications of Heat. Vaporization is the conversion of a volatile substance into a vapor or gaseous condition. When the solid is heated sufficiently so that the expansive force of heat equals the cohesive force of the molecules, a liquid is formed. If the expansive force of the heat exceeds the pressure of the atmosphere, the liquid changes to vapor.

Boiling is the formation of bubbles of vapor below the surface of the liquid, largely at the bottom of the liquid, and the escape of these bubbles causes the agitation. Pressure on a liquid raises the boiling-point, reduction of pressure lowers the boiling-point. This latter fact is made use of in manufacturing laboratories, as in making solid extracts, where the temperature of boiling water would be injurious to the drug. Water may be made to boil below 60° C. by use of the ordinary suction pump, and with a vacuum of twenty-eight inches it will boil at about the temperature of the body.

Evaporation is a term generally applied to vaporization below the boiling-point, and where the residue and not the vapor is wanted. The formation of vapor takes place at the surface of the liquid slowly and quietly. Spontaneous evaporation is where the vaporization takes place at the ordinary temperature. Rapidity of evaporation of a liquid below its boiling-point depends largely upon its volatility, the amount of surface exposed, the amount of heat applied, and upon stirring. Stirring helps to bring freshly warmed liquid to the surface and to break any film that may form so that the vapor escapes more easily. Rapidity of evaporation at the boiling-point of the liquid depends on the extent of the surface which the heat strikes, the thinness of the layer of liquid, and the roughness of the bottom of the container. "Bumping," which is common in boiling alkaline solutions, and which is always troublesome, is due to the sudden liberation of large bubbles of gas at the bottom of the vessel. It can frequently be reduced by having insoluble angular objects, as broken glass, or pieces of pumice stone in the liquid, or by forcing air through it.

In the retail store, evaporation is chiefly carried on in shallow, round-bottom dishes. Dishes are sometimes made of porcelain, glass, platinum, silver, or other material. Enameled iron dishes are not satisfactory, as the enamel and iron do not expand evenly with heat and the enamel is likely to crack. Evaporation will take place much more quickly from an evaporating dish than from a beaker, the high sides of the beaker condensing the vapor and preventing less saturated air from coming in contact with the liquid.

Grommets are rings on which to set hot evaporating dishes so that they will not rock. They may be made of straw or of a piece of rubber tubing with the two ends joined by means of a plug.

Distillation is the vaporization of a liquid and the condensation of the vapor, the condensed liquid or distillate being wanted. Distillation may be for the purpose of purifying a liquid or for recovering it. As heat is necessary for the production of vapor, cold is necessary for condensing it. By knowing the active and latent heat of a vapor the amount of water at a given temperature necessary to condense it to any desired temperature may be easily calculated. This is not done in practice, but the cold is obtained by running water through a condenser.

For ordinary distillation the still consists of a flask of suitable capacity connected by means of a glass tubing with a Liebig or worm condenser. A Liebig condenser consists of a larger outer glass tube through which a small glass tube passes. The ends of the outer tube are sealed or connected to the inner tube, and near each end of the outer tube is a small side tube projecting so that water can be made to pass between the outer and inner tubes. A worm condenser is similar to this except that the inner tube is spiral instead of being straight. The worm condenser has the advantage over the Liebig in that the condensing tube being spiral is much longer, and also, if the liquid is boiling hard, the direction of the vapor is constantly changed and it cannot shoot through without touching the cold tube, as it may in a Liebig condenser. The worm condenser is more expensive and cannot be cleaned as readily, and must be used in the vertical position. An upright or inverted condenser is one in a vertical position. A reflux condenser is one which is vertical or at such an angle that the condensed liquid will flow back into the retort or distilling flask.

There is a great variety of forms of stills and condensers, depending upon the purposes for which used. In making distilled water a block tin condenser is the best. A vacuum still is one in which a partial vacuum is produced, thereby aiding greatly the evaporation of the liquid at a lower temperature and yet recovering the liquid. In a pharmaceutical laboratory vacuum stills are largely used in making fluid and solid extracts.

Some liquids do not readily distill by direct heating, but can be made to volatilize by passing live steam through them, the steam to be generated in a flask connected with the still.

Fractional distillation is simple distillation in which the receiving vessel is changed at intervals as the temperature of the vapor rises. The rise is shown by a thermometer. The distillate is obtained in several fractions and these can be refractioned. This process is used in separating liquids of different boiling-points, as in separating the constituents of crude petroleum oil, or a mixture of ether and alcohol.

Destructive distillation is the heating of an organic substance out of contact with air until it is broken up into volatile compounds and a non-volatile residue. The production of acetic acid, methyl alcohol, and creosote from wood, or illuminating gas, cresol, and phenol from coal, are good examples.

Sublimation is the vaporization of a solid, the vapor changing back to a solid without necessarily passing through the intermediate stage of liquefaction. Quite a number of chemicals can be obtained or purified by sublimation, as iodine, sulphur, mercuric chloride, mercurous chloride, benzoic acid, camphor, etc. If the temperature of the receiver is near that of the retort, the sublimate will be in a mass or cake, as in making corrosive sublimate, but if the temperature of the receiver is considerably below that of the retort, and particularly if steam be injected into it, the sublimate is in the form of a powder, as calomel.

Desiccation and **exsiccation** are often used synonymously, and mean to deprive of moisture. The term desiccation is generally used where the amount of heat is not high, as in drying vegetable drugs. A desiccator is a closed vessel containing sulphuric acid, calcium chloride, lime, or some other substance that has a strong affinity for water. Into the desiccator are put crucibles and articles that have been heated when it is desired that they should not absorb moisture on cooling, or articles that are to be dried at ordinary temperature. Exsiccation is generally applied in cases where a higher heat is used, high enough to drive off water of crystallization. Examples of exsiccation are found in dried alum or dried sodium phosphate.

Torrefaction is the roasting of an organic substance or the heating of it until some of the ingredients are changed while others remain unchanged, as in roasted coffee or roasted rhubarb. **Incineration** is the heating of an organic substance until the carbon is all burned off, leaving nothing but the inorganic ash. This is made use of in determining the purity of vegetable drugs. **Calcination** is the heating of an inorganic compound to a high heat so that volatile components are driven off. Magnesium carbonate when calcined loses carbon dioxide and magnesium oxide is left.

The determination of melting- and boiling-points is used as a test for purity and identity of substances. Different substances vary greatly in their melting-points. To get the **melting-point,** it is customary to introduce some of the solid into a capillary tube, attach this tube to a thermometer so that the solid will be on a level with the bulb, then place them in water, oil, sulphuric acid or other liquid. The liquid is gradually heated, particularly as the melting-point is approached, and stirred; the temperature is noted when the solid liquefies. There is often some variation in temperature between the point where the solid begins to melt and where it is liquefied. There is also considerable difference between the melting- and solidifying-points of the same solid. If fats are melted to get them into the tubes they must be allowed to stand for several hours, as it requires some time for them to regain their normal melting-points.

To determine the **boiling-point**, it is customary to put the liquid into a distilling flask and suspend a thermometer well into the neck but not into the liquid. Increased or lessened atmospheric pressure causes a great variation in the boiling-point.

STERILIZATION

Within the last few years, prophylactic medicine and the giving of biologic products has emphasized the importance of sterilization. Sterilization may be defined as the destruction of, or the freeing from, all living microörganisms. Disinfection is the destruction of pathogenic germs, but not necessarily the destruction of all germs. An antiseptic is an agent which prevents fermentation and putrefaction but does not necessarily arrest these processes after once started.

Agents which produce many diseases and cause fermentation, putrefaction, and other similar changes, are classified under bacilli, micrococci, spirilla, protozoa, molds, fungi, yeasts, and enzymes. Spores are the resting forms of bacteria, and cannot be as easily destroyed as the growing forms. Only a few of the pathogenic bacteria produce spores, and these are generally easily killed.

Water is the almost universal liquid used in making preparations which must be sterilized, and it is one of the ingredients necessary for the growth of microörganisms. Ordinary water and even distilled water after keeping a short time is not sterile. Microörganisms, being small, float about in the air, consequently water, hands, utensils, and containers are all contaminated. It is necessary after sterilizing the preparation, container, and stopper, that the preparation should not be exposed to air any longer than absolutely necessary, and then only under as aseptic conditions as possible.

Sterilization is generally produced by physical means, by chemicals, or by filtration. The first is the one most frequently applied by pharmacists. Sunlight, pure air, and heat are the three great natural disinfectants. While light and air purify a polluted stream they are hardly applicable in pharmacy. Heat is the best means to be employed provided the article or medicine is not injured. A dry heat of 160° C. for an hour will destroy most germs and spores. Moist heat is much more effective than dry heat, and boiling an aqueous solution for a half hour will kill practically all germs, though a longer time may be necessary for a few spores. Unfortunately many chemicals and preparations are decomposed or injured by this heat. In such a case the preparation may be put into a sterile container, the stopper loosely inserted and a piece of parchment paper tied over this. The container is placed in water and the temperature kept at 60° to 80° C. for thirty minutes for three successive days. The stopper is then forced in and the paper tied down tight. In place of the stopper, a plug of cotton can be used, during the sterilization. This is known as fractional or interrupted sterilization. The theory is that the first heating will kill all the germs but not the spores; that the spores will vegetate and will be killed by heating the second day; that the third heating will kill all that have escaped the previous heatings. Milk is pastuerized by heating to 62° C. for twenty-five minutes. This does not change milk, does not kill all bacteria, but most of the pathogenic ones, and makes the milk keep longer.

Sterilization by means of chemicals calls for judgment on the part of pharmacists. They should rarely use other agents than alcohol, sugar, or glycerin as preservatives. These should be present in sufficient amounts to have the desired effect, as in small amounts they may aid decomposition. Many organic preparations are preserved by the presence of 25 per cent of alcohol and some with a smaller amount. Sugar to be a preservative should be in nearly saturated solution.

Many medicinal agents themselves destroy or inhibit the growth of microörganisms, and no other form of sterilization is needed. Metallic salts in general, and those which coagulate albumin in particular, as well as acids, peroxides, oxidizing agents, alcohol, ether, chloroform, formaldehyde, volatile oils, and phenols in general, are preservatives. Sometimes when a preparation has been sterilized it is necessary to put in a small amount of preservative to keep it. Chloroform water in place of water called for in a preparation can sometimes be used to advantage.

Sterilization by filtration is largely done by the manufacturer of biologic products. The filter used is made of unglazed porcelain, the pores of which are sufficiently small to remove all bacteria. This means that filtration will be slow; if it is rapid the probability is that the liquid is not rendered sterile. The filter can be cleaned by heating.

In making up all preparations containing water, it is desirable to use recently boiled distilled water. The laboratory should be kept thoroughly clean and as free from dust as possible. Utensils, containers, and everything used should be protected from contamination. Conditions should be as nearly aseptic as possible.

All liquids which are to be injected intravenously or hypodermically should be sterile and clear. The remedies given in these ways are largely biologic products or alkaloids, and many of these cannot be heated to 100° C. without partial or complete decomposition. Biologic products come from the manufacturer in a sterile condition, but in diluting them sterile physiologic salt solution should be used. Some salts of alkaloids and some organic compounds may be boiled in water, as morphine, codeine, dionin, tropacocaine, betaeucaine, quinine, caffeine, emetine, strychnine, pilocarpine, and strophanthin, but even these are preferably sterilized by the fractional method. Such alkaloids or compounds, as atropine, hyoscyamine, hyoscine, cocaine, physostigmine, stovaine, alypin, heroine, apomorphine, and adrenalin, should not be heated over 60° C. Where there is any doubt, this lower temperature should be used. Ampuls are often the best containers for these solutions. After filling the ampul, it is sealed and sterilized by the fractional method, heating it in water colored with methylene blue or other coloring agent. If an ampul is defective the contents will become colored, and it should be thrown out. Solutions to be applied to broken surfaces, to mucous membranes, as douches, or for irrigation, are preferably sterilized.

Utensils used in sterilizing solutions, containers, and stoppers should first be made aseptic. Glassware, such as funnels, bottles, and jars, should be washed with an alkali followed by an acid and then distilled water, then dried and heated to 160° C. for one hour and afterwards protected from the dust. Bottles should be plugged with absorbent cotton before heating. Frequently glass is alkaline, and bottles to be used with chemicals easily affected by alkalies should be allowed to stand for several hours with acid in them, or heated for a half hour with a 1 per cent hydrochloric acid before sterilizing. Corks can be sterilized by boiling in water or by heating to 130° C. for an hour. Rubber stoppers or caps and collapsible tubes can be sterilized in boiling water.

Surgical instruments, gauzes, bandages, ligatures, catheters, drainage tubes, etc., are not usually sterilized by the retailer, but can be if desired. Glycerin, olive oil, paraffin oil, and ointment bases such as lard, wool fat, and petrolatum, can be heated to 120° C. for two hours without decomposition. For practical purposes, a sterile ointment can be made by using such a base, mixing the medicinal agent with a sterile spatula on a sterilized slab in a sterilizing box or closet.

The U. S. P. on pages 616, 617 and the N. F. on pages xxvii–xxxv treat of the subject of sterilization.

LIGHT

Light is a form of molecular motion which produces the sensation of vision. The present theory is that a luminiferous ether pervades everything, even between molecules, that the molecules of luminous bodies are in rapid vibration, and communicate this vibration to the ether, which transmits it in all directions.

A knowledge of the refraction of light by lenses and prisms is necessary for the understanding of the working of the microscope, polariscope, spectroscope, refractometer, and photographic camera.

The laws of the refraction of light may be stated as follows: 1. When light passes perpendicularly from one medium to another, it is not refracted. 2. When light passes obliquely from a rarer to a denser medium, as air into glass, it is bent towards the perpendicular erected to the surface of the denser medium. 3. When light passes from a denser to a rarer medium, as glass to air, the light is bent away from the perpendicular erected to the surface. In this connection dense and rare do not refer to the specific gravity but to the refractive power.

A lens is a transparent medium which has two curved surfaces or one plane and one curved. If the lens is a double-concave, plano-concave or concavo-convex, parallel rays of light passing through it diverge. If it is a double convex, plano-convex, or meniscus lens, parallel rays of light passing through it converge. Parallel rays of light passing through a double convex lens are twice refracted so that they meet at a certain point, the focus, on the other side of the lens.

A prism is a transparent medium which has two sides not parallel (wedge-shaped). Rays of light passing through a prism are unequally refracted, being broken up into colors known as the solar spectrum. Red, orange, yellow, green, blue, indigo, and violet are known as the primary colors.

Light has three properties: 1. Luminosity; 2. Heat; 3. Chemical action. When light passes through a prism, the luminosity is greatest in the yellow and least in the violet; the heat is greatest beyond the red rays; chemical action is hardly seen in the red, but is greatest beyond the violet (ultra-violet). Because of its chemical action, light is one of the strong natural disinfectants.

Chemical rays of light have a deleterious effect on many preparations and chemicals. Pharmacists do not give the attention to this fact that they should. Different colored bottles have been used to keep out actinic rays; amber is the best while blue has but little effect. Light generally has an oxidizing effect, but in the presence of organic matter, some inorganic salts are reduced.

Some of the preparations and chemicals which should be protected are: Fluidextracts, tinctures, volatile oils, alkaloids and their salts; organic compounds, as santonin, creosote, betanaphthol, iodoform, thymol iodide, ether, chloroform, hydrated chloral; free acids and salts of benzoic, hydriodic, hydrocyanic acids; salts of gold, silver, mercury, arsenic, iron; hydrogen dioxide, formaldehyde, and many others. A glance through the Pharmacopœia will show the importance of preventing the access of light to drugs.

CRYSTALLIZATION

Crystallization is the process by which a solid assumes a definite geometric form, bounded by faces, edges, and angles. Faces of a crystal are the smooth, plane surfaces. Edges are lines formed by the meeting of two faces. Angles are formed by the intersection of three or more faces. Cleavage is the tendency of a crystal to split in a plane parallel with the faces. Axes are imaginary lines running between the centers of opposite faces or apexes of opposite angles, and passing through the center of the crystal. Holohedral crystals are those which have the full number of faces to make a perfectly symmetrical crystal. Hemihedral crystals are those which have only one-half the number of faces to make a symmetrical crystal. Acicular crystals are needle shaped, as caffeine. Prismatic crystals are elongated in the direction of the longest diameter, as potassium permanganate. Tabular crystals have the form of plates, as potassium chlorate. Laminar crystals are similar to tabular ones except that they are thinner, as acetanilid.

If a solid does not crystallize, it is said to be amorphous. If it may be made to crystallize in two forms, it is dimorphous; in three forms, trimorphous; in several forms, polymorphous. If two or more solids crystallize in the same form, they are isomorphous.

Methods. Crystallization may be effected by cooling a hot saturated solution, by evaporating a solution either spontaneously or with heat, by sublimation, by precipitation, by heating short of the fusing point, or by electricity. Many chemicals are obtained by crystallizing from contrated solutions, although a few are obtained by sublimation. In crystallizing from a liquid, a solid sometimes takes with it, in loose combination, a definite amount of water which is known as water of hydration or of crystallization, and which is necessary for the crystal. The number of molecules of water of crystallization for the same compound may vary with the temperature at which it is crystallized. Sodium carbonate crystallizes with ten molecules of water at ordinary temperature, but at 35° C., or above it takes up only one molecule. If a crystal loses a part or all of its water of crystallization, it is said to be efflorescent. If it has no water or the water has been driven off, it is said to be anhydrous.

Solids in crystallizing sometimes mechanically enclose water between their particles; this is known as interstitial water, and because of the crackling noise produced on heating such a crystal, the water is also called water of decrepitation. Mother liquor is the liquid left after crystallization; often it may be concentrated and another crop of crystals obtained.

Crystals grow from without, by the depositing of solid particles. It is not known why particles of solids arrange themselves to make different forms or why some solids crystallize and some do not.

Aids. Crystallization from solution is often facilitated by the addition of a few crystals of the same compound which seems to start the process, as menthol in oil of peppermint; or by putting in some rough foreign substance, as a string in syrup to make rock-candy; or by agitating, as in assaying opium. Quiet and slow evaporation tend to produce the most perfect crystals. Crystallization may also be facilitated by having the liquid in a rough container, as an earthen jar, the projections seeming to aid the formation of crystals; wooden and lead vats are sometimes used. Glass is used for small operations, but it is objectionable because of its smoothness.

If a perfect crystal be suspended in a saturated solution for some time it will often grow to a large one. If a crystal is placed in a saturated solution of an isomorphous compound, the crystal will grow by taking up the solid from the solution. A crystal of potassium aluminum sulphate will increase when left in a saturated solution of an iron alum, the iron alum forming a crystalline coat around the potash alum.

The time required for complete crystallization to take place may be several hours or even days. During the act of crystallizing, the liquid may become warmer because the latent heat required to keep the solid in the liquid condition has been changed to active. The freezing of a large body of water may raise the surrounding temperature so that fruit may not be injured.

Objects. Crystallization is generally resorted to for the purpose of purification. If several solids are in solution, the one which is the least soluble will crystallize first, but in doing so, it may carry with it and have enclosed in the crystals some of the other salts. Several recrystallizations are often necessary to get the compound pure.

There are a great number of crystalline forms, but for convenience they have been reduced to six systems. These systems are based on the number and the length of the axes and the angles at which these meet.

Kinds. In the crystals of the regular system, the axes are three in number, all equal, and intersect at right angles. In the quadratic system the axes are three in number, two equal, and all intersect at right angles. In the rhombic system there are three axes, all unequal, and all intersect at right angles. In the hexagonal system there are four axes, three of which are equal, the fourth being shorter or longer and intersecting the plane of the other three at right angles. In the monoclinic system there are three axes, all unequal in length, two obliquely inclined to each other, the third being at right angles to the plane of the other two. In the triclinic system there are three axes, all unequal, and each intersecting the other obliquely.

BIOLOGIC PRODUCTS

The use of serums and vaccines in the diagnosis and treatment of disease has become an important one and the importance will increase. Pharmacists should give particular attention to these products, for the intelligent keeping of which a knowledge of their properties is necessary.

About 1902, the Federal Government passed a law regulating the interstate sale of these products. At present it is required that all establishments making them for interstate shipment must be licensed annually and be subjected to frequent inspection. The products are examined for bacterial purity, freedom from excessive amount of preservative, and for potency if there be an established standard. The label should show the name of the product, the name and address of the manufacturer, the license number of the manufacturer, the time limit for which the manufacturer is willing to guarantee the agent, the potency if there be a standard, the amount of preservative, and the laboratory serial number. Many State laws provide for a similar control.

Although these products usually contain some added preservative, as cresol, phenol, and glycerin, yet they are very susceptible to change. Practically all should be kept in a refrigerator at a temperature of 4° to 10° C. At this temperature some products will keep for a long time, while others must be replaced with fresh stock. They should not be frozen, although freezing does not seem to hurt them. A table showing the classification as given in the New and Nonofficial Remedies, 1917, is on opposite page.

Antibodies are agents which 1, neutralize or prevent the action of toxins (antitoxins), or, 2, act on the bacteria themselves (antibacterial serums). Blood may contain either or both of these classes.

Antitoxins are agents formed in the body which combine with or neutralize the action of toxins. They are comparatively simple and stable compounds, and their formation is stimulated by the presence of toxins. They produce immediate immunity which lasts for only a short time.

Diphtheria antitoxin is produced by injecting a young, healthy horse at intervals with the toxin from a beef-tea culture of the diphtheria bacilli. Increasing doses of the culture from which the bacteria have been removed are injected into the horse until it has become immune. The horse is then bled, the serum separated from the corpuscles, and generally purified and concentrated. A preservative is added, and the serum is tested to determine its strength. The unit of standardization is one hundred times the amount of antitoxin which is necessary to neutralize the toxin required to kill a guinea pig weighing 250 grams.

- Serums and Vaccines
  - Antibodies
    - Antitoxins
      - Diphtheria
      - Tetanus
    - Anti-bacterial serums
      - Anthrax
      - Antidysenteric
      - Antigonococcus
      - Antimeningococcus
      - Antipneumococcus
      - Antistaphylococcus
      - Antistreptococcus
      - Others
  - Antigens
    - Attenuated living viruses
      - Vaccine virus
      - Antirabic virus
      - Anthrax
      - Blackleg
    - Tuberculins
      - Old Tuberculin (" OT ")
      - Tuberculin residue("TR")
      - Bacilli emulsion ("BE")
      - Bouillon filtrate ("BF")
    - Bacterial vaccines
    - Mixed bacterial vaccines
    - Sensitized bacterial vaccines
      - Acne bacillus
      - Cholera
      - Colon bacillus
      - Diphtheria bacillus
      - Friedlaender bacillus
      - Gonococcus
      - Meningococcus
      - Pertussis bacillus
      - Plague bacillus
      - Pneumococcus
      - Pyocyaneus bacillus
      - Staphylococcus
      - Streptococcus
      - Typhoid
      - Others
  - Diagnostic agents
    - Agglutinating serums for the identification of bacteria
    - Lutein for vaccination in diagnosis of syphilis
    - Toxins for immunity tests

The U. S. P. recognizes diphtheria antitoxin, the purified antitoxin, and the concentrated. The temperature at which the U. S. P. directs the serum to be kept is between 4.5° and 15° C. Under ordinary favorable conditions of keeping, it will still have at the end of two years the potency stated on the label. In making the concentrated serum, many of the constituents other than the antibodies are removed and there is less tendency to cause sickness which blood serum itself sometimes produces. This concentrated product is sometimes known as antidiphtheritic globulin. The dried globulin keeps much longer than the liquid, particularly in warm climates, and the time of potency may be as long as eight years. This dried product may give some trouble because of the difficulty in getting it dissolved in physiological salt solution.

Tetanus antitoxin is obtained from the horse in a manner similar to that used in getting diphtheria antitoxin. What is said in general about the diphtheria is true of the tetanus antitoxin. The concentrated or dried article is generally used. This is about ten times as strong as the serum or purified serum. It can be standardized in a manner similar to that used for diphtheria antitoxin. The unit is one thousand times the amount necessary to neutralize the lethal dose of toxin for a guinea pig weighing 350 grams, keeping the pig alive for four days.

Antibacterial serum contains substances which act on the bacteria themselves or upon the toxins which remain in the bacteria (endotoxins)—those which do not diffuse through the cell. The large majority of bacteria do not form toxins which pass into the culture medium. Some of the antibacterial substances have been called bacteriolysins (which break down bacteria), opsonins (which modify bacteria so that they are taken up by phagocytes), bacteriotropins (specific opsonins), and agglutinins (which cause bacteria to form into clumps or groups). Several other antibodies may be present. Antibacterial serums are more complex than antitoxins and cannot be standardized.

Antigens are agents introduced into the body for the purpose of stimulating the formation of antibodies. Some of the antigens are toxins, ferments, vaccines, viruses, and tuberculins. The immunity caused by antigens comes on more slowly and lasts longer than that given by antitoxins. Most of these serums are obtained from horses after they have been immunized.

There are some cases in which attenuated (diluted or lessened virility) living germs are administered—smallpox and rabies being the more common. The viruses induce mild forms of the diseases, and are given to prevent severer attacks, and not as curative agents. Vaccination against smallpox was first practiced by Jenner in the latter part of the eighteenth century. **Vaccine virus, U. S. P.**, is obtained by inoculating the abdomens of calves or heifers with virus, after shaving and scarifying. After about five to seven days the vaccine pulp or virus is removed, tested, ground up and made into an emulsion with glycerin. This is tested for foreign bacteria, and the animal is also examined for other diseases. The virus is marketed in the form of capillary tubes or glycerinated points. This virus should be kept below a temperature of 10° C., as it quickly deteriorates if kept at the ordinary room temperature. If kept in a refrigerator it will retain its potency for several months, the time limit on the label generally being three months, although with proper precautions it may keep a year.

Antirabic vaccine is produced by passing the germs through a series of rabbits. The brain of a rabbit is inoculated with the germ, and after the animal has died the brain is used to inoculate another, and so on until a product is obtained which will cause the death of the rabbit in six or seven days. The spinal cord of this rabbit may be attenuated by keeping under certain conditions for a given number of days, or by cold, heat, phenol or other antiseptics, and used to inject into the patient who has been bitten. This virus is very susceptible to heat and should be kept at a temperature below 10° C. It is often kept in glycerin. The time limit is usually given as three months.

Tuberculins are products obtained from the tubercle bacilli. They vary considerably in method of obtaining, in composition, and in activity, even when prepared in the same laboratory and in the same way. They contain the water soluble substances from the bacteria, or the ground-up bodies of the bacilli, or mixtures of these. Tuberculins are used as diagnostic and curative agents. They are generally marketed as concentrated preparations in glycerin, or are put up in tablet form. Tuberculin Old (" TO "), or tuberculin Koch contains the soluble products of the tubercle bacilli, and is the one which is chiefly used as a diagnostic agent to test cattle for tuberculosis. It has proved very reliable. It is injected and the animal is watched for any increase in temperature. Tuberculin is also used in diagnosing tuberculosis in persons. In most cases it is not now considered a good curative agent.

Bacterial vaccines or bacterins are preparations in which the dead bacteria are suspended in physiologic salt solution. A culture is made on an artificial medium, as agar, and after twenty-four hours' growth it is washed into a small amount of saline solution, and the number of bacteria estimated. They are then killed by heating or by an antiseptic, and the preparation is diluted so that one milliliter will contain the desired number. This number varies with different bacteria and different-sized doses, generally 20 to 2000 millions in a milliliter. These vaccines have power to stimulate the formation of antibodies. They are used for prophylactic and curative treatment, preferably the former. They may be kept for three months without much change and are usually marketed in liquid or dry form, the latter being suspended in saline solution previous to administration. Of the bacterins, the typhoid is the one which has given the best results.

Mixed bacterins contain the bodies of different strains of bacteria. In diseases, more particularly in secondary infections, there may be several modifications of bacteria present, and the giving of mixed bacterial vaccines is to meet such cases. Unless care is taken in the use of these, they will resemble the old time " shot-gun " prescription.

Serobacterins or sensitized bacterial vaccines differ from bacterins. The particular kind of bacteria being worked with is grown on agar for twenty-four hours, washed into saline solution, mixed with the antiserum specific for that kind of bacteria, and left for several hours. The bacteria are washed free from serum by repeated centrifugalizations with normal salt solution, then suspended in some of the solution, standardized, killed, and a preservative added. The advantages claimed for serobacterins are that the severe sypmtoms sometimes produced by bacterins are lessened and immunity results more quickly.

Autogenous bacterins are preparations made from the bacteria which have been taken from the patient being treated. It is claimed that in this way bacterins are made from the same strains of bacteria with which the patient is suffering.

Stock bacterins is a name applied to bacterins which have been prepared from laboratory cultures.

Some agents belonging to the serums and vaccines which are used for diagnosing diseases are mentioned in the table given above.

Other products recognized by the U. S. P. and coming from the animal kingdom are dried pituitary body, dried suprarenal glands, dried thyroid glands, pepsin, pancreatin, lard, wool fat, beeswax, honey, cod liver oil, sugar of milk, ox gall, musk, spermaceti, cochineal, and cantharides.

HOMŒOPATHIC PHARMACY

In the latter part of the eighteenth century a German physician, Samuel Hahnemann, became dissatisfied with medicine as practiced at that time. From his experiments with cinchona, he became convinced that many drugs given in certain sized doses would produce symptoms similar to those produced by diseases, and that the drug producing symptoms resembling those of a certain disease was the remedy for that disease. He gave two propositions. 1. When two dissimilar abnormal irritations act simultaneously on the body, the weaker irritation will be suppressed or suspended by the stronger. 2. When two similar irritations act on the body, the weaker irritation with its effects will be completely extinguished by the stronger. From these he drew the conclusion that "In order to be able to cure, we shall only require to oppose to the existing abnormal irritation of the disease an appropriate medicine, that is to say, another morbific power whose effect is very similar to that of the disease." From this came the doctrine that "Like cures like."

Cleanliness is stressed by homœopathic pharmacy. It is advised to use a separate mortar for the trituration of each separate drug, and where this is not practical, to cleanse the mortar thoroughly and then pour alcohol in and burn it. Bottles and utensils are to be cleaned, rinsed with distilled water, and then with alcohol. Vegetable drugs should not come in contact with iron or other metals except tin.

The distinctive feature in administering is simplicity. Drugs are not mixed, but given singly, although sometimes one is given alternately with another. They are added to some vehicle which acts as a preservative or diluent. Great care should be taken in storing them to keep one from being contaminated with the odor or dust of another. Drugs must be "proved," that is, the drug is given to a large number of healthy individuals in order to determine its physiological effect in different sized doses.

The standard of strength seems to vary with different practitioners. The Pharmacopœia of the American Institute of Homœopathy gives the following: "In every instance, the dry, crude substance is to be taken as the starting point from whence to calculate its strength," and "Mother tinctures contain all the soluble matter of one grain of the dry plant in ten minims of the tincture," English measure, or 10 Cc. represents 1 gram of drug. The fresh drugs are used to make the tinctures, but the moisture is first determined and the strength of the tincture calculated from the dried drug.

Two standards for diluting tinctures and trituration have been used, the decimal and the centesimal, but the Ph. of the Amer. Inst. of Homœopathy follows the former. With few exceptions all mother tinctures are practically 10 per cent or 1X. In the decimal system the mother tincture is represented by the character ϕ or θ or by "1X" or "$\frac{1}{10}$." To make the 2X, 1 Cc. of the 1X tincture is mixed with 9 Cc. of the alcoholic liquid and this makes a 1 per cent tincture or $\frac{1}{100}$ and 1 Cc. of this with 9 Cc. of the alcoholic liquid makes the 3X or $\frac{1}{1000}$, or a 0.1 per cent tincture. The centesimal system is represented by the even numbers before the X or by figures, or a figure before c. The first centesimal dilution is practically a 1 per cent tincture or 2X, 1, or 1c. To make the second dilution 1 Cc. of this is mixed with 99 Cc. of the alcoholic menstruum and this makes 1 part of the drug in 10,000 of the tincture and is represented by 4X, 2 or 2c. When certain drugs are insoluble in 10 parts of water, their original solutions should be prepared in the proportion of 1 in 100 or in 1000, depending upon the solubility and then these solutions or tinctures should be considered the second decimal, 2X, or the third decimal, 3X, respectively.

Menstruums, solvents, vehicles, or diluents should be as nearly inert as possible, such as water, glycerin, alcohol, sugar of milk, and should be as pure as can be obtained. While alcohol is not inert, on account of its solvent and preservative properties it is largely used. Alcohol of the Homœopathic Pharmacopœia contains about 91 per cent by weight or 94 per cent by volume of alcohol, should be kept in glass containers, and is used chiefly in making tinctures. Officinal or dispensing alcohol contains about 83 per cent by weight or 88 per cent by volume of alcohol and is used in making most dilutions from tinctures.

In making tinctures from fresh succulent drugs, the drug should be put into alcohol as soon as possible, and if this cannot be done at once it should be kept at a temperature of about 0° C. In making the tincture the drug should be bruised in a Wedgwood mortar or minced in a machine coated with tin. The process of maceration is preferable, putting the requisite amount of alcohol on the drug and allowing to stand for two to four weeks, decanting, expressing, and filtering if necessary. Percolation is more frequently used for dried drugs.

Triturations are medicinal substances, usually insoluble, ground with sugar of milk which is hard and gritty and grinds up the drug into smaller particles. In making a trituration one part of drug is mixed with 9 parts of sugar of milk and triturated until the largest particles of the drug do not measure more than $\frac{1}{100}$ of an inch in diameter. Formerly the directions were to triturate for one hour. This makes the 1X trituration. To make the 2X, take 1 part of the 1X and mix with 9 parts of sugar of milk and triturate until the drug particles do not measure over $\frac{1}{2000}$ of an inch. In the 3X and 4X the particles should not measure more than $\frac{1}{4000}$ of an inch.

Tincture triturations are made by adding 10 Cc. of a tincture to 10 grams of sugar of milk, mixing and allowing the menstruum to evaporate. If a 1X tincture is used, the finished product is represented with a dash over the 1X, as $\overline{1X}$; or if a 2X tincture has been used, by $\overline{2X}$.

Trituration tablets may be made by dampening a trituration with water or dilute alcohol, pressing into tablets, and drying.

Medicated globules, pellets or pilules are globular masses of cane sugar, and are specified by the diameter in millimeters of ten of them in a row. They are medicated by pouring on them a sufficient amount of the dilution to saturate them, the excess being afterwards removed.

Medicated cones or disks are made from cane sugar and are made more absorbent by the addition of a small amount of egg albumin. They are designated by the diameter of the base and are medicated like globules.

THE PRESCRIPTION

The prescription is a written order from the physician to the pharmacist, requesting that certain drugs be furnished to the patient. Latin or abbreviated Latin is often the language in which it is written. One reason for this is that the Latin name rarely applies to more than one drug. It is also sometimes used to keep the patient from knowing what medicine is being taken. Aside from knowing the Latin names of drugs, the pharmacist can get along with a very slight knowledge of that language.

Receiving. On receiving a prescription, the pharmacist should not show by facial expression or in any other way his thoughts regarding it. The confidence of the patient in the prescriber and the compounder must not be lessened. If the prescription is not readily legible or if there seems to be an error, the prescriptionist should retire and consult references or the writer. If the prescription is to be called for or delivered, or in a large store even if the customer waits, he should be given a check bearing the same number as the check which goes with the prescription. The pharmacist must be exceedingly careful how he answers questions asked by the patient regarding the physician or the prescription. Before commencing to fill a prescription, it should be carefully read and thoroughly understood. Some pharmacists write the label the first thing so that it will be dry by the time that it is to be applied. The writing should be done with a typewriter. The label should be plain, of good stock paper, thin but opaque.

Incompatibility. Three kinds of incompatibility are possible, physiological, physical, and chemical. The pharmacist has nothing to do with the first one. Physical incompatibility is where agents do not make homogeneous mixtures or where an agent is thrown out of solution without chemical reaction taking place, as in adding water to spirit of camphor. The pharmacist should know how to mix ingredients so as to prevent incompatibility if it can be done.

Checking. Some system of checking prescriptions should be conscientiously followed out in every store. The pharmacist is liable to be sued by a person claiming that a prescription has been filled incorrectly. If he can show to the court that he uses a system of checking which makes an error almost impossible, he stands a much better chance of winning the case. Different systems are used. One is for the person who has filled the prescription to call off from memory the ingredients and the amounts which he has put in, another clerk checking them on the written prescription. When there is only one prescriptionist, he may collect at his left hand all of the ingredients to be used and as he uses them place them at his right hand or on a shelf behind him. He should observe the labels closely the third time when he puts the containers back in their places, to see that he has put in the things called for.

Notes. The compounder should make note on the prescription of anything added, as pill excipient, or any change made, or the order of mixing if that will make any difference to the finished product. When the prescription is refilled, it should be like the original, otherwise the patient will think that an error has been made.

Refilling. It is customary to refill prescriptions unless prohibited by the physician or by law. When a physician does not want it to be refilled he can so write on the prescription. The refilling of prescriptions calling for certain narcotic drugs is prohibited by law.

Filing. Various ways of filing prescriptions are used, as stringing them on a wire, pasting in a book, copying them in a book, binding in packs of one or two hundred or more, filing in boxes, and pasting on cards. The last method has advantages over others.

Ownership. It has been a much-discussed point as to who owns the prescription—the physician who wrote it, the patient who paid for it, or the pharmacist who filled it. The pharmacist generally retains it and in some States is required to do so. If the prescription calls for certain narcotic agents, any pharmacist filling it must keep it for two years. In any case the pharmacist should keep it for his own protection.

Wrapping. The label should be put squarely on the bottle, covered by another paper and all wrinkles rubbed out. The bottle or package should be neatly and skillfully wrapped. It is by these small things that the patient judges the ability of the pharmacist.

PRACTICAL PHARMACY

LIQUID PREPARATIONS FOR LOCAL APPLICATIONS

LINIMENTS

Definition. A liniment is a liquid preparation to be applied externally with friction, having as its base alcohol, a mixture of alcohol and water, a fixed oil, or a volatile oil. Difficulty is rarely experienced in making liniments, as they are often mixtures of immiscible liquids or liquids and solids, and are generally dispensed with a " shake well " label. Water is not a good vehicle, because it and the agent dissolved in it are not readily absorbed. The fixed oils most commonly used are cottonseed, olive, linseed, sesame, expressed oil of almonds, and liquid petrolatum. Oil of turpentine is about the only volatile oil used as a base, although it and others are used for medicinal effect. The friction and massage with which liniments are applied are often beneficial.

COMMENTS

Linimentum Ammoniæ, *Volatile Liniment.* Oil of sesame consists chiefly of olein which is acted upon by ammonia, making soap and glycerin.

$$\underset{\text{Olein}}{C_3H_5(C_{18}H_{33}O_2)_3} + \underset{\substack{\text{Ammonia}\\\text{water}}}{3NH_4OH} = \underset{\text{Ammonium oleate}}{3NH_4C_{18}H_{33}O_2} + \underset{\text{Glycerin}}{C_3H_5(OH)_3}$$

The reaction goes on slowly and the liniment becomes thicker. A fresh non-rancid oil acts more slowly with an alkali than a rancid oil which always contains free fat acids. Oil of sesame has replaced olive oil and cottonseed oil in this liniment. The soap formed keeps the undecomposed oil and the water mixed for a time, but they will separate into two layers on standing.

Linimentum Calcis, *Lime Liniment, Carron Oil.* A reaction similar to the one in ammonia liniment takes place. Calcium hydroxide with linolein gives calcium linoleate (a soap), glycerin and water. The soap formed helps to keep the balance of the oil and water mixed. This liniment gets thicker because of the gradual formation of soap.

Linimentum Camphoræ, *Camphorated Oil.* The heat directed aids the solution of camphor. As no heat is applied after adding the camphor the bottle can be stoppered tightly to prevent loss of camphor. Camphor will dissolve much more quickly if it is finely broken up. The container used in making it should not contain water or moisture.

Linimentum Chloroformi. In making chloroform liniment it sometimes separates into two layers. This is due to the use of too much water in making soap liniment, or the evaporation of alcohol. If the soap liniment is properly made it contains enough alcohol to enable it to mix clear with chloroform.

Linimentum Saponis, *Liquid Opodeldoc.* The mixture is set aside for twenty-four hours in order to allow precipitation of sodium palmitate, which is an impurity in sodium oleate and is less soluble. Any excess of sodium oleate will also be precipitated. It is better to filter at a low temperature so that if the liniment is chilled it will not precipitate. In bar soap the amount of water varies greatly, consequently it is not as good as the dried granulated soap in which the water is more constant, and which makes a more constant soap-content in the finished product. In the formula of the U. S. P. VIII, heat was used to dissolve the soap, and in replacing the water which was evaporated sometimes too much water was added, or some of the alcohol was evaporated. The percentage of alcohol was sometimes so low that the liniment would not make a clear solution with chloroform.

Linimentum Terebinthinæ, *Kentish's Ointment.* The rosin cerate should not be heated much above its melting-point when the oil of turpentine is added, otherwise the oil would be partly volatilized.

Linimentum Ammonii Iodidi, N. F. This liniment also contains a little ammonium iodate, as shown by the following equation, which represents the chief reaction:

$$\underset{\substack{\text{Ammonium}\\\text{hydroxide}}}{6NH_4OH} + \underset{\text{Iodine}}{6I} = \underset{\substack{\text{Ammonium}\\\text{iodide}}}{5NH_4I} + \underset{\substack{\text{Ammonium}\\\text{iodate}}}{NH_4IO_3} + \underset{\text{Water}}{3H_2O}.$$

An excess of ammonia is used, and on standing the iodine is all combined and the liniment becomes nearly colorless. Perhaps a little iodine combines with the oils and camphor. Under certain conditions, particularly when iodine is in excess of the ammonia, an explosive iodide of nitrogen is formed.

Linimentum Opii Compositum, *Canada Liniment,* N. F. Egg albumin is used to keep the other ingredients mixed. Oil of turpentine is a volatile oil and is not saponified by ammonia as a fixed oil would be. Ammonia liberates the alkaloids of opium from their salts, but the alkaloids are not precipitated.

Linimentum Saponato-Camphoratum, *Solid Opodeldoc,*

N. F. The liquids are solidified by the sodium stearate formed, a small amount solidifying a large volume of liquid.

$$\underset{\substack{\text{Sodium}\\ \text{carbonate}}}{Na_2CO_3} + \underset{\text{Stearic acid}}{2HC_{18}H_{35}O_2} = \underset{\text{Sodium stearate}}{2NaC_{18}H_{35}O_2} + \underset{\substack{\text{Carbon}\\ \text{dioxide}}}{CO_2} + \underset{\text{Water}}{H_2O}$$

As there is an excess of acid over the carbonate, some ammonium stearate may be formed.

Linimentum Sinapis Compositum, *Compound Liniment of Mustard,* N. F. Most fixed oils are only sparingly soluble in alcohol, but castor oil is an exception, it being soluble in about an equal volume of alcohol.

Linimentum Terebinthinæ Aceticum, N. F. Hen's eggs act as a suspending agent, holding the other ingredients mixed for a time.

OLEATES

Definition. An oleate is a compound of a metal or an alkaloid with oleic acid, and is generally dissolved in an excess of oleic acid or a mixture of oleic acid and olive oil. Pure or nearly pure salts of oleic acid are solid.

Methods of Making. They may be made by direct combination of acid and base, but in case of metallic oleates they are better made by double decomposition, a solution of a salt being mixed with a solution of castile soap, which is chiefly sodium oleate. Lead plaster is in reality lead oleate, and according to the U. S. P. VIII, it was made by pouring a solution of lead acetate into a solution of soap. Except those of the alkalies, the oleates are insoluble in water. They do not keep well and should be made up fresh. Solid oleates keep better than those in solution. They keep better if made without heat. The claim has been made that oleates are more quickly absorbed than other external preparations. They are sometimes mixed with ointment bases.

The five N. F. oleates are oleates of alkaloids, and they are liquid on account of the excess of acid used. Reaction takes place between the free alkaloid and oleic acid. In four of the oleates, olive oil is used as a diluent. In the oleates of atropine and cocaine alcohol is used to aid solution of the alkaloid and this aids chemical reaction. The alcohol is later evaporated.

COMMENTS

Oleatum Hydrargyri, *Oleate of Mercury.* This is the only oleate recognized by the U. S. P. The directions are to heat to a temperature not exceeding 50° C. If made without any heat it takes longer, but does not decompose or deposit metallic mercury so quickly. This oleate is a soft translucent mass.

$$\underset{\text{Mercuric oxide}}{HgO} + \underset{\text{Oleic acid}}{2HC_{18}H_{33}O_2} = \underset{\text{Mercuric oleate}}{Hg(C_{18}H_{33}O_2)_2} + \underset{\text{Water}}{H_2O}.$$

PETROXOLINS

Definition. Petroxolins are generally liquid preparations for external application, the base consisting of liquid petrolatum, oleic acid, ammonia, oil of lavender and alcohol. The acid and ammonia form a soap which dissolves in liquid petrolatum. The proportion of acid and ammonia varies in different formulas, but in the liquid petroxolin they are present in about molecular proportions, the acid being in slight excess.

$$\underset{\text{Oleic acid}}{HC_{18}H_{33}O_2} + \underset{\text{Ammonia}}{NH_4OH} = \underset{\text{Ammonium oleate}}{NH_4C_{18}H_{33}O_2} + \underset{\text{Water}}{H_2O}.$$

The N. F. previously gave formulas for two petroxolins, but the number has been increased to twenty. Two petroxolins are solid.

COMMENTS

Petroxolinum Hydrargyri, *Mercury Petrox,* N. F. This is a solid preparation in which mercury is present in a finely divided metallic condition.

Petroxolinum Iodi, N. F. Following the directions given, there is undoubtedly some reaction between iodine and ammonia, ammonium iodide and ammonium iodate being formed. These are perhaps later decomposed by the excess of acid. Some of the iodine combines slowly with oleic acid, making an addition product. Oleic acid and ammonia unite to form an oleate.

Petroxolinum Liquidum, *Liquid Petrox,* N. F. This is used as the base for several other petroxolins. There is a small excess of acid used. Heating on a water-bath for one-half to two hours may be necessary before a clear liquid is obtained. Probably most of the alcohol and a part of the water is evaporated.

Petroxolinum Sulphuratum, N. F. Sulphur must be heated with linseed oil for several hours before it is dissolved, and the heating darkens the preparation. During the heating a small amount of liquid will be seen to have separated from the oil; this is melted sulphur.

SPRAYS

Sprays are liquid preparations in which the base is light liquid petrolatum, containing a volatile oil, phenol, ketone or similar compound, and intended to be used with an atomizer. This class is not recognized by the U. S. P., and was not in the previous edition of the N. F. Most sprays are simple solutions, and are easily made. Liquid petrolatum is a solvent for a limited number of substances. Sometimes the medicinal agent, if insoluble in liquid petrolatum, can first be dissolved in a fixed oil or in liquid petroxolin, and then in the liquid petrolatum. Small amounts of free alkaloids can be dissolved in liquid petrolatum, but it is often better to convert them into oleates, which are more soluble in this liquid.

INFUSED OILS

This class is recognized by the N. F. but not by the U. S. P., and the N. F. gives only a general formula. Infused oils are generally made from drugs containing alkaloids. Most alkaloids exist naturally in combination with an acid, and these salts are not soluble in oil. Ammonia is used to liberate the bases and make them soluble in oil. Alcohol is used because it penetrates the drug better and dissolves out the alkaloids more completely. The alcohol and ammonia are later evaporated, leaving the alkaloids dissolved in the oil.

LOTIONS

Definition. Lotions are liquid preparations for external application in which the liquid is water, or water with glycerin. In many commercial face lotions a small amount of tragacanth (1 per cent) or mucilage of quince seed is used. Tragacanth contains two gums; one is soluble in water, and the other is not soluble but swells in water. Enough of tragacanth should be used to keep the insoluble portion suspended, but not enough to make it too thick.

The amount of glycerin should not be so much as to leave the face and hands sticky. If quince seed is used, care should be taken not to use that which has been eaten by bugs, as little particles of the dark coat are liable to get into the finished product and are difficult to remove. Lotions should not be filtered. The N. F. recognizes four, and the U. S. P. none. A " shake well " label should be used with each.

COMMENTS

Lotio Ammoniacalis Camphorata, *Sedative Water,* N. F. A small amount of camphor is precipitated. Camphor, being lighter than water, is difficult to keep suspended.

Lotio Flava, *Yellow Wash, Aqua Phagedænica Flava,* N. F. The solution of mercuric chloride is poured into the lime water, not the lime water into the mercuric chloride, so as to have an excess of calcium hydroxide. If the lime water is weak or is not in excess, a red-brown basic chloride of mercury is formed instead of the yellow oxide.

$$\underset{\substack{\text{Mercuric}\\\text{chloride}}}{HgCl_2} + \underset{\substack{\text{Calcium}\\\text{hydroxide}}}{Ca(OH)_2} = \underset{\substack{\text{Mercuric}\\\text{oxide}}}{HgO} + \underset{\substack{\text{Calcium}\\\text{chloride}}}{CaCl_2} + \underset{\text{Water}}{H_2O}.$$

Lotio Nigra, *Black Lotion, Aqua Phagedænica Nigra,* N. F. The following reaction takes place, the black precipitate being mercurous oxide:

$$\underset{\substack{\text{Mercurous}\\\text{chloride}}}{2HgCl} + \underset{\substack{\text{Calcium}\\\text{hydroxide}}}{Ca(OH)_2} = \underset{\substack{\text{Mercurous}\\\text{oxide}}}{Hg_2O} + \underset{\substack{\text{Calcium}\\\text{chloride}}}{CaCl_2} + \underset{\text{Water}}{H_2O}.$$

Lotio Plumbi et Opii, *Lead and Opium Wash,* N. F. Some of the lead is precipitated as the sulphate, and some as the meconate, because of the sulphuric and meconic acids with which the alkaloids of opium are combined. Some of the resinous matter of the tincture is precipitated, but the alkaloids remain in solution. Physicians frequently prescribe tincture of opium with solution of lead subacetate (laudanum with lead water), and the alkaloids are precipitated here because the solution of lead subacetate is alkaline.

COLLODIONS

Definition. Collodion is a solution of pyroxylin in a mixture of alcohol and ether, which mixture is a better solvent than either alone. Pyroxylin or gun cotton is made by treating purified cotton with a mixture of sulphuric and nitric acids, and is chiefly cellulose tetranitrate. Pyroxylin is also used with camphor in making celluloid. When the solvent in collodion has volatilized there is left a thin membrane which is impervious to air and water and which contracts. The five N. F. collodions are simple solutions of medicinal agents in flexible collodion. Bottles containing collodion should be kept tightly stoppered, and after some has been poured out the neck of the bottle should be wiped off to prevent the cork from sticking.

COMMENTS

Collodium Cantharidatum, *Blistering Collodion.* The Spanish flies are extracted with acetone acidified with glacial acetic acid, and the solvent is evaporated; the residue makes a nearly clear solution with flexible collodion. If the flies were macerated with collodion it would be difficult to remove the insoluble part. It is said that the extract made with acetone gives a more permanent collodion than when made with chloroform, which was formerly used.

Collodium Flexile. The residue from flexible collodion, containing camphor and castor oil, does not contract as much as that from plain collodion, and is not as stiff.

Collodium Salicylici Compositum, N. F. This is similar in composition to many of the liquid corn remedies on the market, though perhaps not quite as strong.

SOLID PREPARATIONS FOR LOCAL APPLICATION

OINTMENTS

Definition. An ointment is a solid preparation for external application with friction, and of such consistency that it will generally melt at or below the temperature of the body. Ointments are used for their local or their systemic effects, and to get the best results a knowledge of the bases is required. The articles most commonly used as bases are petrolatum, wool fat, lard, lard with wax, sodium stearate, casein, and glycerite of starch.

Bases. Petrolatum is a mixture of hydrocarbons obtained from petroleum by distilling off the more volatile and liquid portions, and deodorizing and decolorizing the residue. Petrolatum is not readily absorbed, and agents mixed with it are not readily absorbed, consequently it is good as a protective agent and for the application of antiseptics, but not good for systemic remedies. It does not become rancid or change quickly. It can be made to take up about 5 per cent of water, but the addition of 5 per cent of beeswax enables considerably more water to be taken up. When a watery or alcoholic preparation is to be mixed with petrolatum, the liquid can first be mixed with wool fat and then with petrolatum. It melts between 38° and 54° C., and should be free from acids or chemicals used in purifying it. In warm weather it may be stiffened by adding some paraffin.

Wool fat is a complex mixture of which cholesterin is an important constituent. It is obtained from the washings of wool by treating with a weak alkali, washing with water, precipitating with calcium chloride, dehydrating, extracting with acetone, and evaporating the solvent. The anhydrous fat thus obtained is too stiff and sticky to be used alone as a base, but is mixed with water to make the hydrous wool fat which contains between 25 and 30 per cent of water. Hydrous wool fat is somewhat sticky, but the addition of a little petrolatum will make it less so. Anhydrous wool fat melts between 38° and 42° C. It can be mixed with twice its weight of water and still retain its ointment-like properties; it is chiefly used in ointments where a large amount of liquid is to be taken up. Hydrous wool fat does not readily become rancid. The claim is made that it is more readily absorbed than other ointment bases, and medicines mixed with it are more easily absorbed. Some writers have questioned this statement.

Lard consists mainly of olein, stearin, and palmitin. The best is obtained in cold weather from the "leaves" of the hog. It melts between 36° and 42° C., and should be free from salt, alkalies, and water. It soon becomes rancid, and in that condition is irritating to a tender or abraded skin. Anhydrous lard keeps best, water tending to cause it to become rancid. Melted lard should be quickly chilled and stirred to prevent granulation. Lard can be made to take up from 15 to 20 per cent of water, but a small amount of alkali in it enables a much larger amount to be taken up. Hot weather may liquefy lard, and in such a case the U. S. P. allows the addition of 5 per cent of white wax. Paraffin is more liable to make the ointment granular than wax.

Benzoinated lard is made by keeping benzoin in melted lard for two hours. Lard dissolves benzoic and cinnamic acids and volatile oil, all of which act as antiseptics, retarding rancidity. A temperature higher than 60° C. should not be used because of danger of volatilizing the acids and oil. Lard may be benzoinated at the time of preparing. Some pharmacists benzoinate lard by adding tincture of benzoin and evaporating the alcohol, but this leaves an excess of resin. Others prefer to make a strong solution of benzoin in alcohol, add it to castor oil and evaporate off the alcohol and then add the oil to the lard. In its power of being absorbed, lard comes between petrolatum and wool fat, and nearer the latter.

Sodium stearate and casein are used in the so-called greaseless or vanishing cold creams and massage preparations. Sodium stearate is made by reaction between sodium carbonate and commercial stearic acid, and it has the property of holding a large amount of water. Casein is obtained from milk by removing the fat and precipitating the casein with an acid. The process is tedious, and after the ointment is made it contracts and forces out some water. These preparations often leave the skin dry and hard.

Glycerite of starch has the advantage that it can be washed off with water, but it has the disadvantage that it absorbs water from the air and liquefies. It is not often used.

Methods of Making. Ointments are made by incorporation, by fusion, and one (nitrate of mercury) by chemical action. If the remedy to be incorporated is solid, it should first be reduced to an impalpable powder, a soft mass, or a solution. Sometimes it is better to rub the medicinal agent with a liquid in which it is insoluble, as water, oil, or a part of the melted base, before mixing with the balance of the base. In such a case the liquid aids powdering and prevents reduction of a salt to the metallic state. If the medicinal agent is soluble and crystalline, it is not desirable, as a general rule, to dissolve it in water, as the water may vaporize, leaving the salt in gritty crystals. Solid extracts should be softened with water or dilute alcohol. Medicinal agents soluble in fats should be dissolved in a liquefied portion of the base. Free alkaloids are best rubbed with a little oleic acid, which converts them into oleates. Agents which are likely to react with each other should be rubbed with separate portions of the base first. If a hard ointment is to be mixed with a softer one, the hard ointment should be warmed gently and well rubbed down before adding the softer one. If liquids are to be incorporated, they should be added in small portions, mixing well after each addition, or they should be taken up with some wool fat and then mixed with the base. If a large amount of powder is to be incorporated, part of the base should be melted and rubbed with the powder first. A very active agent should be mixed thoroughly with a small portion of the base and then with other portions.

The ingredients of an ointment are usually mixed on a glass slab with a spatula, although sometimes a mortar is preferred. In the case of agents, like iodine, mercury salts, and acids, that attack an iron spatula, use a rubber, horn, or wooden one.

When an ointment or ointment base is to be made by melting several agents together, the ingredient having the highest melting-point should be melted first, and then the one having the next, so that the ones having lower melting-points will not be injured by heat. In most cases the heat of a water-bath is sufficient. A mixture of agents having different solidifying-points should generally be stirred while cooling to prevent granulation caused by the ingredient having the highest melting-point solidifying first.

Further stirring makes it whiter, but incorporates air, which tends to make it become rancid. If water is to be incorporated with melted fats, the mixture must be stirred until cold.

In cleaning utensils, the greater part of the grease can best be wiped out with sawdust. To remove the odor of iodoform or similar bodies from a mortar, wash the mortar with oil of turpentine and then with soap and water, or pour in a little alcohol and set fire to it.

Keeping. Stock containers for ointments should be made of porcelain or glass, and should be thoroughly cleaned before putting in a fresh lot of ointment, because an old ointment will soon cause the new one to become rancid. The surface of china-ware containers becomes cracked, and grease gets in and becomes rancid and cannot be removed. Ointments should be kept in a cool, dry place. It is best to make up only a small amount which will be used up in a reasonable time.

Dispensing. Glass jars are generally used as containers for dispensing ointments. Tin boxes are cheaper but are sometimes attacked by the ointment, which may then become discolored. Turned-wood boxes are not satisfactory even when coated with liquid glass or a similar substance, as the ointment invariably gets into the pores and becomes offensive. Collapsible tubes are the most expensive but the best containers, as the ointment is protected from the air and is more sanitary, because the finger is not put into it as it is when a jar is used. The best tubes are made of tin, while the cheapest contain a large percentage of lead. In filling the tube, if the ointment is soft it can be run in, or if hard it can be rolled into a cylinder and slipped in, and the end of the tube sealed by folding. Difficulty is experienced in getting the label to stick to the tube. The label should be long enough so that it will go around the tube and the ends overlap. Or the tube can be dispensed in a carton bearing the directions, then the label will not be soiled or destroyed in forcing the ointment out by squeezing or rolling the end of the tube.

COMMENTS

Unguentum. This is often designated as "simple ointment." Using white wax makes a whiter ointment than yellow wax, but the ointment is more liable to become rancid. In bleaching wax it undergoes some change so that white wax does not have the antiseptic properties which yellow wax has.

Unguentum Acidi Borici. This ointment contains less paraffin and is softer than that of the U. S. P. VIII. Boric acid is not dissolved in the melted base and the ointment must be stirred until congealed.

Unguentum Acidi Tannici. Tannic acid does not dissolve in simple ointment. If glycerin is not used and the ointment is heated much above its melting-point, tannic acid will fuse into a mass which cannot be distributed. There is but little danger of that trouble with the present formula, but the heat must be continued until the acid is completely dissolved. It is advised to avoid iron utensils to prevent discoloration by black tannate of iron, but there is little danger of this when using a bright steel spatula.

Unguentum Aquæ Rosæ, *Cold Cream.* The mixture of wax, spermaceti, and oil should not have a temperature much above its melting-point when the rose water is added, or the oil of rose will be volatilized. The water should be warm when added, otherwise the fatty ingredients will be partly solidified and a lumpy ointment produced.

Stirring should be continued until the mixture is cold to prevent separation of water, and further stirring makes a whiter ointment by incorporation of air, but this tends to quicken rancidity. Water makes the ointment softer and more creamy. Borax, being alkaline, probably forms a soap, and makes the ointment whiter. Borax may be objectionable because of its reaction with other agents which may be added, and in such a case it may be left out. Many of the commercial cold creams are made with liquid petrolatum and paraffin because of cheapness and better keeping qualities. The base of greaseless cold creams is generally made by the action of sodium carbonate on stearic acid, at the same time incorporating a large amount of water. Casein is less frequently used.

Unguentum Belladonnæ. Wool fat is used to take up the partly liquefied extract and to aid absorption. It is essential that the extract be thoroughly rubbed up to a smooth mass before mixing with the fat because of the difficulty of making a homogeneous mixture afterwards. Dark particles in the ointment show that it has not been thoroughly mixed. Of the two belladonna extracts official, the pilular one is used because it is more easily incorporated.

Unguentum Diachylon. The melted mixture of lead plaster and petrolatum should be cooled nearly to the congealing-point before adding the oil of lavender to prevent volatilization of the oil. Olive oil was formerly used in place of petrolatum.

Unguentum Hydrargyri, *Mercurial Ointment.* Oleate of mercury is used to break the mercury into fine globules (extinguish). This ointment should be kept in a cool place to prevent the settling out of the heavy mercury. No chemical reaction takes place, the mercury being in the metallic condition, except that in the oleate.

Unguentum Hydrargyri Dilutum, *Dilute Mercurial Ointment.* The name "blue ointment" is now applied to the weaker ointment because the stronger one to which it was formerly applied is too strong to be used without the physician's directions. This ointment now contains 30 per cent of metallic mercury.

Unguentum Hydrargyri Nitratis, *Citrine Ointment.* Two chemical reactions take place in making this ointment; one between lard and nitric acid making elaidin and nitric oxide, and which cannot well be shown by an equation; the other between mercury and nitric acid.

$$\underset{\text{Mercury}}{3Hg} + \underset{\text{Nitric acid}}{8HNO_3} = \underset{\substack{\text{Mercuric}\\\text{nitrate}}}{3Hg(NO_3)_2} + \underset{\substack{\text{Nitric}\\\text{oxide}}}{2NO} + \underset{\text{Water}}{4H_2O}.$$

The reaction between the lard and nitric acid should be complete before the mercuric nitrate is added, otherwise the mercuric salt is slowly reduced to mercurous. The ointment should not be handled with a steel spatula because of the acid attacking the iron and the mercuric nitrate depositing metallic mercury on it. Commercial ointments vary from a light yellow to a dark red-brown color, depending to some extent upon the condition of the ingredients, and the amount of heat used. Stirring for some time after the ointment is cold makes it lighter, but incorporates air. In making very small amounts of ointment, a heat higher than that directed is required.

Unguentum Hydrargyri Oxidi Flavi. In this ointment, as well as in that of the red oxide of mercury, N. F., the oxide is rubbed with water to reduce it to a very fine powder. The wool fat takes up the water and tends to prevent discoloration and reduction to metallic mercury. This ointment is largely used for the eye, consequently great care should be used to get it free from gritty matter.

Unguentum Iodi. Iodine cannot be reduced to a fine powder, so it is dissolved in a solution of potassium iodide. If water were used to dissolve the iodide, it would evaporate to some extent and leave the iodide in small gritty crystals; glycerin does not evaporate. Iodine slowly combines with lard, and the ointment should be made up fresh. If a metallic spatula were used, iodine would attack it at once.

Unguentum Iodoformi. Iodoform can be reduced to a fine powder more easily by triturating with a little alcohol.

Unguentum Phenolis, *Carbolic Acid Ointment.* The base now used is simple ointment in place of petrolatum, formerly used. Theoretically, at least, petrolatum is preferable because it is not as readily absorbed. Simple ointment will take up liquefied phenol better than petrolatum. The strength has been reduced from 3 to 2.25 per cent.

Unguentum Picis Liquidæ, *Tar Ointment.* The ingredients should not be heated very hot, as heat tends to make the ointment granular.

Unguentum Zinci Oxidi. This ointment is apt to become granular, and the oxide is prone to separate. Made with some wool fat it seems to stand better. Only a very fine powder of zinc oxide should be used. A far superior product can be made by running the ointment through a small paint mill.

Unguentum Calaminæ, N. F. There seems to be but little need of this formula, as the U. S. P. gives one for zinc oxide. Calamine is an impure zinc carbonate containing, according to the N. F., a varying amount of zinc silicate or ferric oxide. It has about the same effect as zinc oxide.

Unguentum Potassii Iodidi, N. F. Potassium iodide cannot easily be reduced to a powder, and for that reason it is dissolved in water. In solution it soon liberates iodine and discolors the ointment, particularly if the lard is rancid and has free fat acids in it. Sodium thiosulphate is used to prevent the liberation, and to reduce any liberated iodine to an iodide. The formula in the U. S. P. VIII directed the use of potassium carbonate instead of sodium thiosulphate. Potassium carbonate has the property of neutralizing free fat acids, of preventing liberation of iodine, of reducing iodine, and of preventing evaporation of water which would cause the crystallization of the iodide. If the present N. F. directions are followed to dispense only " freshly prepared " ointment, these troubles will not be experienced.

Unguentum Resorcinolis Compositum, N. F. This ointment changes color on exposure to air and light, becoming more of a red, due to oxidation of resorcin. It should be well protected and not kept too long. Oil of cade has been replaced by rectified oil of birch, and paraffin by yellow wax; a smoother ointment can now be made.

Unguentum Sulphuris Alkalinum, *Hebra's Itch Ointment,* N. F. Potassium carbonate slowly reacts with lard, forming soap.

INUNCTIONS

The N. F. recognizes two preparations under this title, menthol inunction and compound menthol inunction. These might better be put under ointments, as the base is wool fat.

DERMATOLOGIC PASTES

Dermatologic pastes are preparations resembling ointments, and, in fact, several of them might well be classed as ointments, as they contain petrolatum, benzoated lard, or liquid petrolatum. While they vary in composition, they generally contain an antiseptic or astringent. Starch is used in three to stiffen the mixture or to act as a diluent.

Pasta Dextrinata, N. F. This is probably intended as a vehicle, as it was used for that in the previous edition of the N. F. It is a thick liquid rather than a paste.

Pasta Zinci Mollis, N. F. A reaction slowly goes on between linseed oil and lime water, forming a soap, similar to the reaction in lime liniment.

PLASMAS AND POULTICES

These two classes are similar in that they are external preparations and can be washed off with water. Plasmas are masses made from gelatin, dextrin, starch, or mucilaginous or albuminous matter, with water, glycerin, or a mixture of these. Glycerite of starch is an example of a plasma. Tragacanth, quince seed, Irish moss, and agar are other drugs used.

A poultice is generally prepared in the home and is used to impart heat and moisture. Linseed meal is stirred with hot water and spread thickly on a cloth. The surface may be smeared with olive oil to prevent it sticking to the surface of the body and irritating when it has become dry. Powdered mustard should be mixed with lukewarm water in order that the ferment may act on sinigrin and develop the volatile oil which is the active principle. If hot water is used the ferment will be destroyed before the oil is formed. If it is desired to have the mustard poultice hot, the mixture of mustard and warm water can be added to a hot linseed poultice. Slippery elm, marshmallow, sassafras pith, bread and milk, and other agents are used.

Cataplasm is another name for poultice. The N. F. gives a formula for cataplasm of kaolin. The kaolin (white clay), is thoroughly dried, and glycerin as free from water as possible is used. This preparation is a dehydrating remedy and an antiphlogistic. It is spread on cloth before applying.

MULLS

Salve mulls (steatins), according to the N. F., are ointments of high melting-points spread on mull (thin muslin). Directions for spreading are given. The usual base is a mixture of lard and suet, sometimes with the addition of wax, the medicinal agent being an antiseptic or astringent.

GLYCEROGELATINS

Glycerogelatins are soft masses containing gelatin, glycerin, water, and usually an antiseptic or astringent agent. They can be washed off with water. The N. F. uses the U. S. P. glycerinated gelatin with an additional amount of glycerin, mixing the medicinal agent first with the glycerin and then with the melted glycerinated gelatin.

Gelatinum Glycerinatum. Gelatin does not readily dissolve in strong glycerin. It is first allowed to soak in cold water until softened, the excess of water poured off, glycerin added, and then heated on a water-bath until reduced to the weight of gelatin and glycerin taken. The water is practically all evaporated, and also a small amount of glycerin, as this is slightly volatile at that temperature. Glycerinated gelatin is too stiff to use alone. In using it to make suppositories or glycerogelatins, more glycerin should be added.

CERATES

Definition. A cerate is a preparation for external application of such consistency that it will soften at the temperature of the body but not usually liquefy. The general remarks under ointments apply equally well to cerates. Being stiffer than ointments, they keep better.

COMMENTS

Ceratum. Simple cerate is similar to simple ointment, except that it contains 30 per cent of white wax, while the ointment contains 20 per cent.

Ceratum Cantharidis, *Blistering Cerate.* Cantharides is macerated with a mixture of oil of turpentine and glacial acetic acid to dissolve partially the active principle cantharidin. The melted rosin, wax, and lard is strained to remove foreign matter, but the mixture should not be strained after cantharides is added. During the heating of the cantharides and base, the base takes up the cantharidin, and a part of the oil and acid is evaporated. This cerate is used in spreading plaster of cantharides.

Ceratum Resinæ, *Basilicon Ointment.* This should not be stirred much when cooling because air is incorporated and stirring is not necessary with this cerate.

Ceratum Plumbi Subacetatis, *Goulard's Cerate,* N. F. Wool fat helps to take up the solution. This cerate keeps much better than when made with camphor cerate as the base.

PLASTERS

Definition. A plaster is a solid preparation for external application and of such consistency that it will become adhesive but not soft at the temperature of the body. Heat must be used in spreading it. A plaster may be used to give support or strength to a part of the body or to produce medicinal effect. While plasters are used to some extent, the retail pharmacist is rarely called on to make or spread them, this being done by the large manufacturer. The U. S. P. plasters were formerly made with lead plaster as the base, but some of them now contain rubber. Large manufacturers use rubber with other constituents. It is a disputed question whether a plaster made with a rubber base gives up its medicinal agents as readily as one made with lead plaster.

Preparation. In preparing this rubber base, the rubber is steeped in hot water, and passed through crushers at the same time that it is being washed with a stream of water. It is then immersed in an alkaline bath and rolled into sheets. The sheets are passed through grinders until they are soft and plastic. Other constituents are now incorporated, such as burgundy pitch, or olibanum, first volatilizing any turpentine and neutralizing any acid. Often beeswax is used, and sometimes orris root as a filler. Next the medicinal agent, as extract of belladonna, mercury, iron, etc., is incorporated and the whole spread on cloth by passing between rollers set far enough apart to give the proper thickness. Frequently the plaster is perforated to allow the escape of exhalations from the skin, thus making it less disagreeable.

In making plasters the pharmacist will follow the same general directions in incorporating the medicinal agents as in making ointments, getting the agent into an impalpable powder or soft solid. Plasters made with lead plaster as the base should not be spread before they are wanted, but the plaster mass can be kept protected from air and light. Plasters are usually spread on muslin, but where greater support is wanted soft plaster skin is used. A form the size and shape of the plaster wanted is cut out of cardboard about the thickness of a calling card, and then tacked down on muslin to hold it in place. The mass is softened with heat, but not so that it will soak through the cloth. The surface is then smoothed with a spatula warmed by dipping into hot water. After the plaster is cold, the edge of a spatula is run around the margin to loosen the form. A margin of cloth about half an inch in width is left around the plaster to prevent the mass from oozing out as it becomes warm. A piece of tarletan is put over the face of the plaster to protect it.

COMMENTS

Emplastrum Belladonnæ. No formula is now given for making this plaster. The commercial machine-made plaster is sanctioned. In fact this is the only kind of belladonna plaster that has been used for years. The U. S. P. requires it to come up to a definite standard.

Emplastrum Cantharidis. When a plaster of cantharides has been called for heretofore, the cerate was spread on muslin. The U. S. P. now gives the preference to one spread over a resin plaster, leaving a margin of resin plaster not covered so that it will stick to the surface of the body.

Emplastrum Capsici. The pharmacist can easily spread this and also the cantharides plaster, and should spread them as wanted. The U. S. P. directs the amount of active preparations to be used.

Emplastrum Elastici, *Rubber Adhesive Plaster.* This is often called adhesive, surgeon's, or sticking plaster, and it contains a much larger amount of rubber than was directed in the formula of the U. S. P. VIII. This plaster is sometimes mixed with zinc oxide and spread on muslin, and is then called zinc oxide adhesive plaster.

Emplastrum Plumbi, *Diachylon Plaster.* The method of making lead plaster is practically that of the U. S. P. VII except that part of the olive oil is replaced by lard. Olive oil consists chiefly of olein. Lard contains olein, stearin and palmitin. When these are heated with lead oxide and water, lead oleate and glycerin are formed together with some stearate and palmitate.

$$\underset{\text{Olein}}{2C_3H_5(C_{18}H_{33}O_2)_3}+\underset{\substack{\text{Lead}\\\text{oxide}}}{3PbO}+\underset{\text{Water}}{3H_2O}$$
$$=\underset{\text{Lead oleate}}{3Pb(C_{18}H_{33}O_2)_2}+\underset{\text{Glycerin}}{2C_3H_5(OH)_3}.$$

Similar reactions take place with stearin and with palmitin. Glycerin is washed out with warm water. The oleate should be nearly white. Water is necessary for chemical reaction, and that lost by evaporation must be replaced, using boiling water so as not to chill the mixture. Water also helps to keep the temperature down and lessen danger of burning. In the U. S. P. VIII the plaster was made by pouring a hot solution of lead acetate into a solution of soap. Soap is chiefly sodium oleate with a little stearate and palmitate. This method is much easier than the one now official. To clean utensils soiled with lead oleate, wash with oil of turpentine and then with soap and water.

Emplastrum Sinapis, *Mustard Plaster, Mustard Paper.* No formula is given for this, but the product is practically the same as that made by the formula given under mustard paper in the U. S. P. VIII. The fixed oil is removed by extracting with petroleum benzin because the fixed oil is inert and would prevent the mass from sticking so well to paper and cloth, and would also make a greasy preparation. Rubber is dissolved in benzin and carbon disulphide, the fat-free mustard is mixed with this, and spread. The plaster should be kept dry, otherwise the ferment present acts on the sinigrin, forming the volatile oil, and the plaster would be weakened. Black mustard is used, as it forms a volatile oil which is more effective than the acrid compound formed from white mustard. A mustard paper should be dipped into warm water before applying to the body.

Emplastrum Fuscus Camphoratum, *Camphorated Mother Plaster,* N. F. On boiling red lead with olive oil, a reaction takes place somewhat similar to that in making lead plaster, but no water is added, and the oil is partly oxidized. The brown color is probably due to some of the oxidation and decomposition products.

PENCILS

Paste pencils are rod-shaped solids, about $\frac{1}{8}$ inch in diameter and 2 inches long, made of a paste of starch, dextrin, tragacanth, sugar, and water, and containing some medicinal agent. They are intended to be moistened and applied to a limited area, as a caustic or local anæsthetic. The formula for salicylic acid pencils, N. F., is the only one given. Sometimes chemicals, as silver nitrate or alum, are molded into the form of pencils.

SUPPOSITORIES

Definition. A suppository is a solid mass containing medicinal matter to be injected into one of the orifices of the body (rectum, urethra, vagina, nose, or ear), usually for local effect. Unless otherwise specified, a rectal suppository is the kind wanted. The term bougie is sometimes applied to urethral or nasal suppositories, and sometimes to instruments used for dilating orifices. A pessary is an instrument placed in the vagina for the support of the uterus, but the word is sometimes applied to a vaginal suppository.

Shape and Size. The U. S. P. gives directions regarding the shape and size of suppositories. When glycerinated gelatin is used as the base, the suppository can weigh more without being any larger than when made with oil of theobroma. The Wellcome suppository differs in shape from these in that while one end is pointed for introduction, near this end the suppository reaches its largest diameter and then slowly becomes smaller towards the flat end. The advantage of this is that the largest part of the suppository can be inserted beyond the sphincter muscle, and the muscle contracting from the stimulus of a foreign body will force the suppository in rather than out.

Bases. The three bases most commonly used are oil of theobroma (cacao or cocoa butter), glycerinated gelatin, and soap, although others have been proposed. Each has certain advantages and disadvantages, but the first one mentioned is used unless otherwise specified. Oil of theobroma is a firm solid at ordinary temperature, melts below the temperature of the body, has a bland, soothing effect, and does not become rancid. On the other hand it is not good for urethral or nasal suppositories, as these being small in diameter are easily broken. Cacao butter is softened by some agents, as chloral hydrate, phenol, menthol, and naphthalene. In hot weather it is difficult to work on account of its becoming too soft. In such cases the fusing-point may be raised by melting the oil with from

5 to 15 per cent of spermaceti, care being used not to get it above the temperature of the body. Spermaceti is preferable to wax. A little castor oil is said to have a hardening effect. A large amount of drying powder should not be used, as it raises the melting-point and may cause pain on inserting. If necessary, the surface of the suppository may be warmed a little to aid insertion.

Gelatin softened with water and glycerin makes a suppository which does not break easily, consequently it is good in making urethral or nasal suppositories. Glycerinated gelatin, U. S. P., can be used if it is melted and mixed with an equal amount of glycerin; the medicinal agent can be dissolved in or mixed with the glycerin. Some medicinal agents tend to soften the base, while others, as tannic acid, alum, or ichthyol, may render it insoluble. Gelatin suppositories dissolve in the fluids of the body, and just before inserting the suppository it should be dipped in warm water, which makes it more slippery.

Castile soap, or preferably curd soap (animal soap), is occasionally used. It is incompatible with metallic or alkaloidal salts, and itself has a laxative effect. Sodium stearate is used in making glycerin suppositories, as it will solidify a large amount of glycerin.

Methods of Making. The directions for making an ointment mass hold true for making a suppository mass. The medicinal agent must be in the form of an impalpable powder, soft solid, or liquid, and be thoroughly mixed with the base. Suppositories are made by hand, by molding, or by pressure. When they are to be made by hand, the butter is shaved or grated and a part of it rubbed down to a mass in the mortar, and to this are added the medicinal agents previously brought to the proper condition. In cold weather if the mass is crumbly the trouble can be remedied by warming slightly or by adding a little petrolatum or fixed oil, as castor or olive. The mass is then rolled into a cylinder on a pill tile which has been dusted with lycopodium, the cylinder is cut into the required number of suppositories and the proper shape given. If the mass is too soft on account of the weather or ingredients, it will harden if set aside for an hour or two in a cool place.

If suppositories are to be made by molding, the butter is melted, the medicinal agents mixed with it, and when about to solidify it is poured into molds which have been well chilled on ice. Excess of heat should be avoided, particularly if such agents as tannic acid or iodoform are present, because heat causes these to make hard masses. On letting the mold stand in a cool place the suppositories shrink so that they can be removed from the mold. Considerable judgment must be used as to the proper time for pouring the liquid into the mold, because if it is too warm the insoluble medicinal agents will settle to the apex of the suppository, and if the mixture is too stiff it will not run down and fill the apex of the mold. To prevent suppositories from sticking to the mold, the latter should be clean and well polished, and in some cases it may be dusted with lycopodium or swabbed with glycerin. Glycerin is better than olive or other oil because it does not readily mix with the butter, but it cannot be used for this in making gelatin suppositories. Various forms of molds are used, the nickel-plated separable form being about the best. Having a given mold, it is desirable to know the weight of cacao butter it will hold in order to know how much butter to use in a formula for suppositories which are to be molded.

When suppositories are to be made by pressure, the mass is made up the same as for making by hand. It may be necessary to chill the mass so that when pressed the suppositories will retain their form. The pressure method is generally more satisfactory than either of the other two. If a pharmacist has many suppositories to make, it will pay him to get a pressure mold.

Suppository shells made of cacao butter have been on the market, but are not very satisfactory. The medicinal matter is put into the shell. The cap is warmed slightly and placed on the shell, sealing it when cold. These shells are rather expensive, and often it is nearly as much work to get the medicinal matter into them as to make suppositories, and when the shell melts all of the medicinal matter is liberated at once instead of exerting the prolonged effect obtained while the suppository is melting. Shells made of gelatin are occasionally used.

Dispensing. Suppositories are best dispensed in boxes having partitions, each suppository being thus kept from touching another. If a partitioned box is not used, each suppository should be wrapped separately in paraffined paper or tin foil, or separated by absorbent cotton. In any case the box should be lined with some impervious material, as paraffined paper. Agents given by rectal injection are slowly absorbed, and the dose is larger than when given by mouth. Strychnine is said to be an exception to this last statement, and the dose should be smaller.

COMMENTS

Suppositoria Glycerini. Reaction takes place between sodium carbonate and stearic acid, and is complete when the evolution of carbon dioxide ceases.

$$\underset{\text{Stearic acid}}{2HC_{18}H_{35}O_2} + \underset{\substack{\text{Sodium}\\ \text{carbonate}}}{Na_2CO_3} = \underset{\text{Sodium stearate}}{2NaC_{18}H_{35}O_2} + \underset{\substack{\text{Carbon}\\ \text{dioxide}}}{CO_2} + \underset{\text{Water}}{H_2O}.$$

The melted mixture should be stirred while heating because the sodium carbonate is in the glycerin and the acid floats on top. The finished mass contains approximately 93 per cent of glycerin. The suppositories when cold should be translucent. If they are white it indicates that chemical action was not complete. Glycerin suppositories are very deliquescent, soon liquefying on exposure to air. They may be dipped into collodion, melted paraffin or cacao butter, or wrapped in tin foil or paraffined paper, and even then they should be kept in tightly stoppered bottles. The patient should be instructed to remove any coating which may have been used, before inserting the suppository.

SOLID PREPARATIONS FOR INTERNAL ADMINISTRATION

POWDERS

Definition. Powders, according to the U. S. P., are mixtures of finely divided medicinal solids. Single agents, as calomel, may also be dispensed in the form of powders.

Advantages. This method of administering medicines is advantageous in case of children or other persons who have difficulty in swallowing pills or capsules. Powders are more easily carried by persons who are traveling or are so engaged that liquids are not convenient. Heavy metallic salts and other insoluble compounds sometimes act better when given in the form of powders. There is less danger of chemical reaction when agents are mixed dry than when mixed with water.

Disadvantages. Not all solids are suited for giving in the form of powders. Some absorb moisture from the air, as potassium acetate. Some give off water of crystallization, as sodium phosphate. Some are oxidized in the air, as ferrous sulphate. Some cause explosion when rubbed together, as potassium chlorate with organic matter. Some make a mass or liquid when rubbed together because of liberation of water of crystallization brought about by chemical reaction, as lead acetate with zinc sulphate. Some liquefy, because of new liquid products formed, as camphor with thymol.

Mixing. Before mixing the ingredients of a powder, each one should be in a fine state of subdivision, unless where one is gritty and will help to powder the others. If small amounts of ingredients are to be mixed, it is best done in a mortar, but larger amounts can be mixed on paper. All powders are more thoroughly mixed by passing through a sieve. If a powder is to be given by insufflation, it should be passed through a sieve, or better still, a bolting cloth, to make it light and fluffy, as rubbing in a mortar makes it dense and heavy. In mixing a small amount of active agent with a large amount of a comparatively inactive agent, the stronger should be thoroughly mixed with a small portion of the inactive agent (e.g., sugar of milk), and then with further portions. By so doing the mixture will be more perfect. The same principle holds true in making ointments or other mixtures.

Dividing. Various forms of mechanical appliances have been made to divide a powder into a given number of equal portions. These may be of service when the amount in a dose is large, but when the dose is a few grains or less the powder can best be divided by forming it into a square or rectangle on a pill tile, and, with a spatula, dividing into the required number of doses. With a little practice this can be done with accuracy.

Dispensing. Powders divided into doses are generally dispensed in well-calendered papers or capsules. If a powder is likely to change in air, it should be wrapped in waxed or paraffined paper. If only three or four powders are to be dispensed at a time, they are best put into an envelope, but if more, they should be put into a box. They should be folded so that the length will be the same as the inside length of the box and the width the same as the depth of the box, and they should be of uniform size. Powders are usually taken by dropping on the back part of the tongue and then washing down with water. Sometimes they are first mixed with water in a tablespoon, or better, with syrup, because this is more viscid and will hold the powder in suspension. Some powders, like quinine sulphate, can be easily filled into capsules by forcing the capsule into the crystalline powder, while others do not stick in the capsule and must be pushed in with a spatula. If a large number of capsules are to be filled at one time, one of the several capsule fillers on the market may be used with advantage. In place of capsules, cachets or konseals are sometimes used. They are made from rice flour, of a somewhat concave disk shape, so that when the two halves are stuck together with the powder inside they look something like a biscuit. These have the advantage of being more easily swallowed and more easily disintegrated in the stomach than gelatin capsules. If the powder is to be dispensed in bulk, it may be put into a box, but if it changes in air it should be put into a wide-mouth bottle, a paper being laid over the mouth of the bottle before inserting the cork, so that particles of cork will not fall into the powder.

Fineness of Powders. The Pharmacopœia frequently directs that a vegetable powder to be used shall be in a certain degree of fineness, as a "No. 80 powder." This number has reference to the number of meshes to the linear inch in the sieve through which the powder must pass. The gauge of the wire should also be stated, because the larger the wire the smaller the opening between the wires. The U. S. P. now gives to the numbered powders a maximum size which the particles passing through the sieve shall have. Words are also sometimes used to describe the powder. A " No. 80 powder " is a " very fine powder " in which the " diameter of particles " shall be " less than 0.17 millimeter." [See U. S. P., page 612.]

COMMENTS

Pulvis Aromaticus. The U. S. P. directs the use of cardamon seed " deprived of pericarps," because the pericarp contains but little oil and is difficult to powder.

Pulvis Cretæ Compositus. Compound chalk powder is not prescribed as such by the physician, but is used only in making chalk mixture, which is a mixture of this powder with water and cinnamon water. Acacia makes the water more viscid and helps to suspend the chalk in the mixture. Sugar aids suspension and sweetens the mixture. Prepared chalk, although less pure than crystalline precipitated calcium carbonate, is smoother and finer.

Pulvis Effervescens Compositus, *Seidlitz Powder.* Sodium bicarbonate and potassium and sodium tartrate are wrapped in one package and tartaric acid in another, because if all were mixed together the mixture would absorb moisture in a damp atmosphere and some chemical reaction would take place. In taking, the two packages are dissolved in separate portions of water and the acid solution is poured into the other. Sodium bicarbonate and tartaric acid are used to make carbon dioxide which lessens the disagreeable taste of Rochelle salt. Two colored papers are used so that there will be no danger of getting two packages of the mixture or of the acid. Tartaric acid in a damp atmosphere will decolorize blue paper and will itself be colored, so it is put into white paper. The small wooden measures used by some manufacturers for measuring the mixture and the acid instead of weighing the powders are not accurate, as the amount pressed into the measure varies with the moisture, with the pressure, and with the degree to which the measure has been worn off.

Pulvis Glycyrrhizæ Compositus, *Compound Licorice Powder.* Oil of fennel is preferred to the powdered seed because it keeps better. It is used to give a flavor and to relieve the griping caused by senna. It is triturated with sugar because it can thus be more intimately mixed than if it is added to senna or licorice. The powder should be kept in well-closed containers to prevent oxidation and volatilization of the oil.

Pulvis Ipecacuanhæ et Opii, *Dover's Powder.* Sugar of milk is used as a diluent. A No. 30 powder which is coarse and gritty is used because in reducing it to a fine powder it, in turn, reduces the other ingredients to finer powders. The ingredients should be so thoroughly mixed that when the powder is rubbed out on the pill tile no white spots or streaks will be seen.

Pulvis Rhei Compositus. Experience has shown that the ingredients can be more readily mixed in the order directed by the U. S. P. than otherwise. The powder gradually becomes of a reddish color, due to the alkaline magnesium oxide acting on the emodin and coloring matter in the rhubarb.

Pulvis Acetanilidi Compositus, N. F. This is largely used as a headache powder. Acetanilid has a depressing effect on the heart, while caffeine has a stimulating one.

Caffeine partially counteracts the depressing effect, and also relieves some forms of headaches. Sodium bicarbonate neutralizes some of the excessive acidity of the stomach which is often present.

Pulvis Antisepticus, *Soluble Antiseptic Powder*, N. F. Phenol, menthol, and thymol, although all solids, will give a liquid when rubbed together, which mixes with eucalyptol. While this is called soluble antiseptic powder, it is not very soluble, as boric acid which is present in largest proportion requires 18 parts of water for solution.

Pulvis Pancreatini Compositus, *Peptonizing Powder*, N. F. Pancreatin acts best in a neutral or alkaline mixture, and for this reason sodium bicarbonate is used. This powder is used for predigesting foods besides peptonizing milk.

Pulvis Rhei et Magnesiæ Anisatus, *Compound Anise Powder*, N. F. This powder is largely given to infants, and the dose should not be more bulky than is necessary. Heavy magnesium oxide is used here because it is less bulky than the light oxide which is more commonly used.

Pulvis Talci Compositus, *Boro-salicylated Talc*, N. F. This powder, when applied to an irritated surface, as in prickly heat, causes a burning sensation on account of the salicylic acid present. The common borated talcums of commerce do not contain salicylic acid, and are not as strong antiseptically. Boric acid when diluted is not irritating.

TRITURATIONS

Definition. According to the general formula in the U. S. P., a trituration can be defined as a powder consisting of one part of active agent thoroughly mixed with nine parts of sugar of milk. The trituration of elaterin is the only one official.

The strength of triturations of the Homœopathic Pharmacopœia is shown by the number of times the letter X is used. An X trituration is one made by rubbing one part of an active agent with nine parts of sugar of milk. A XX trituration is made by mixing one part of an X trituration with nine parts of sugar of milk, and contains 1 per cent of active agent. A XXX trituration is made by mixing one part of a XX trituration with nine parts of sugar of milk, and contains 0.1 per cent of active agent.

OIL SUGARS

Definition. The National Formulary oil sugars are preparations made by triturating 2 mils of volatile oil with 100 Gms. of powdered sugar. Only a general formula is given. Oil sugars are limited to domestic practice. Volatile oils when finely divided and exposed to air are oxidized and lose their fine flavor, consequently oil sugars should be made up fresh when wanted.

GRANULAR EFFERVESCING POWDERS

Granular effervescing powders are used quite extensively, the saline purgatives particularly being put up in this form. Sodium bicarbonate and citric or tartaric or both acids are put in to cause effervescence, the carbon dioxide liberated making the preparation more palatable. This is a class of preparations which the retail pharmacist can easily make on a small scale.

If a plain effervescing powder is wanted without its being in the form of granules, each ingredient is powdered separately and dried before mixing. If the powder is to be granulated, one of three methods may be used.

Methods of Granulating. 1. The mixed powders are heated to between 83° and 104° C., and while hot passed through a sieve. 2. The mixed powders are heated to 100° C. and stirred. 3. The mixed powders are dampened with strong alcohol and passed through a sieve. If the first or second methods are used, a varying amount of citric acid is necessary. Generally a mixture of citric and tartaric acids is used, the proportion depending upon the medicinal agent. Heating citric acid liberates water of crystallization and makes the mixture sticky. If the chemicals other than citric acid contain water of crystallization, the water should first be driven off from these. If sugar is one of the ingredients, heating it may cause the preparation to become a little yellow, due to caramelization. Some directions call for mixing the sugar with the bicarbonate first to protect it as far as possible from the acid which tends to cause caramelization.

The method first mentioned is the one used by the U. S. P. and is very satisfactory if the conditions are just right. The dish or plate used should be heated before the powder is put in; the powder should not be stirred much; just when it is sufficiently adhesive it is to be forced through a No. 6 sieve; only small amounts should be heated at a time. It does not take long for the powder to get dried out so that it cannot be granulated. A tinned-iron sieve is preferable, but a galvanized-iron sieve will generally answer the purpose for a retail pharmacist.

Both the first and second methods mentioned are given by the N. F. The second requires less care but the granules are apt to be uneven in size. In the third mentioned method tartaric acid is used without citric acid, all the ingredients should be thoroughly dried, and only strong alcohol added, using no more than is necessary to make the powder stick together. Even strong alcohol contains some water which is not as volatile as alcohol. The water on being left dissolves the ingredients a little and causes chemical reaction. More drying is required in this method than in the other two, and in the drying more reaction takes place.

If the granulated powder contains many fine granules, these should be sifted out and may be powdered and worked in with a fresh batch or may be regranulated by the alcohol method. All effervescing and granulated powders should be protected from the light to prevent discoloration, and from the air to prevent absorption of water, for they are hygroscopic. They should be thoroughly dried before bottling, otherwise sufficient carbon dioxide may be formed to burst the bottle.

PILLS

Definition. A pill is a mass of medicinal matter, of a round or ovoid shape, usually weighing from one to five grains, intended to be swallowed whole. According to the National Formulary, a granule is a small pill weighing from one-third to one grain, and a parvule weighs less than a third of a grain. A bolus is a very large pill. The maximum weight is determined by the size. A pill made of dense heavy material may weigh as much as ten grains and yet be no larger than one containing five grains of a light bulky material.

Advantages. The advantages of giving medicine in pill form lie in the smallness of bulk, the convenience of carrying, and the ability to cover up disagreeable tasting matter. Resins, extracts, nauseous and insoluble drugs can be given in pills. Bulky powders are not adapted for this form of administration. Liquids, unless the dose is small, and soluble salts whose strong solutions are irritating, should not be prescribed in pills. A large proportion of the pills whose formulas are given in the U. S. P. and N. F. are purgative in action. Pills disintegrate and act slowly and so do purgatives.

Method of Making. The ingredients are made into a pill mass the requisites of which are that it be plastic, easily molded, not too hard, but firm enough to keep the form into which it is rolled, and of such nature that it will disintegrate in the alimentary canal. The ingredients should be in a fine powder, soft mass, or liquid. Potent agents may be first mixed with a little sugar of milk to get them thoroughly distributed. Pilular extracts may be weighed on paper dusted with lycopodium to prevent sticking, and if necessary the extract should be softened with dilute alcohol before mixing with other ingredients.

It is better to make up the mass by rubbing in a mortar rather than on a pill tile, because more pressure can be used and less excipient is necessary on account of the heat of rubbing and the more thorough mixing. The mass should be frequently scraped down with a stiff spatula. After getting the mass into proper condition, it is rolled into a rod of even diameter and of such length that it will cover the same number of graduations on the pill tile as the number of pills wanted, and then divided. These little masses may be rounded in a pill machine or with the fingers, and then rolled under a pill finisher. A dusting powder is necessary to keep the mass from sticking to the tile. Lycopodium is best for this in most cases, as only a little is required and it repels moisture. Powdered licorice root is good if the mass is wet. Starch is used when the ingredients are white. In dispensing freshly made pills they should be rolled in powder if there is any danger of their sticking, but all excess of powder should be removed before sending out.

Excipients. Medicinal matter is made into a suitable mass by means of excipients, an excipient being an inert agent used for this purpose. They should not be used in excess, and the mixture should be thoroughly triturated before adding more. Excipients are divided into four classes: 1. Those which develop adhesiveness. 2. Those which impart adhesiveness. 3. Those which dry up liquids or soft masses. 4. Those which are used with easily reduced chemicals.

Excipients belonging to the first class are water, alcohol, glycerin, and acids. To make a plastic mass these must partly dissolve the medicinal matter, although many compounds do not become plastic when partly dissolved. Water is used with some extracts, with gummy matter, or with soap. Alcohol is used with some extracts and resinous compounds, but the mass is apt to become tough or crumbly. Glycerin alone is not good because it absorbs water and the pills become too soft on keeping, or with some metallic oxides it makes hard cements. Used with some excipients in the second group, glycerin is good. Acids, as tartaric or dilute sulphuric, are sometimes used with quinine sulphate, converting the normal salt into the acid one, the mass being plastic for a few minutes only.

Numerous substances are used under the second class of excipients. Glucose, syrup, mucilage of acacia, and other gums or mucilages make good plastic masses, but are objectionable because the pills become hard on drying and may pass through the entire alimentary canal without disintegrating. If a little glycerin is added to any of these, the trouble is prevented, because glycerin holds some moisture. A mixture of mucilage of acacia, glucose, and glycerin makes a good general excipient. Honey makes an adhesive mass, but imparts some color. Powdered soap with water makes a good excipient for menthol, phenol, camphor, and similar compounds. It is particularly good with resins, oleoresins, and oils (one part of soap to two parts of oil), because it makes a good mass, and it helps to emulsify them and thus aids their absorption. It should not be used with metallic or alkaloidal salts, because it makes insoluble oleates with the former and free alkaloids with the latter. In using soap and water, there is great danger of getting in too much water. Water should be added a little at a time and only after thorough trituration of that previously added. Glycerite of starch or of tragacanth makes a good general excipient for quinine, acetanilid, and bulky organic compounds. Extract of gentian has been used, but it gives a dark color, has a bitter taste, has a therapeutic action, and should not be used. Confection of rose is bulky and can be used where the amount of medicinal matter is small; it has no advantage over honey or syrup. Manna with water is good for metallic iron, and insoluble metallic salts. Extract of malt has been used. A fixed oil, like castor, makes a good mass with some organic compounds, as sodium salicylate or acetanilid. Pepsin has been recommended for pills of oils, creosote, etc.

Under the third class of excipients, absorbent powders are used to take up the moisture. Powdered glycyrrhiza root is one of the best because it is a good absorbent, and, being fibrous, binds the mass together; it makes a pill that disintegrates quite easily, but some adhesive agent is generally necessary with it. Slippery elm is a good absorbent, and, containing mucilage, can be used with water to make a mass, but the pills are apt to get hard. Althæa contains mucilaginous matter, and pills made with it do not become as hard as when made with acacia or tragacanth. Powdered tragacanth is objectionable because it is not a good absorbent, the pills become hard when dry, and if much is used the mass is spongy and difficult to roll into round pills. Light magnesium carbonate absorbs a large amount of liquid, but combines with many oils, resins, and other compounds, and in some cases makes a pill which will not disintegrate. It should be used in only a few instances, and then with a little water. If three or four minims of oil are to be made into one pill, it can be stiffened by adding to it about half its weight of melted beeswax, being careful that the melting-point of the mixture shall not be above the temperature of the body. Sufficient drying powder is then used. Starched wax, made by shaving wax, drying it, and rubbing with an equal weight of starch, is claimed to be better than wax alone. Bread crumb (mica panis), was formerly used.

The fourth class of excipients includes those which do not cause the reduction of chemicals like potassium permanganate, silver nitrate, or gold chloride. All of the excipients mentioned above will decompose such chemicals. Petrolatum with kaolin (white clay) as a drying powder may be used, or a mixture of equal parts of petrolatum, paraffin, and kaolin. Wool fat is more adhesive than petrolatum. Anhydrous sodium sulphate with two parts of kaolin and one or two parts of water makes a mass which becomes hard and crumbly in a few minutes. Kaolin can be used as the dusting powder with oxidizing agents.

Coating. Pills are sometimes coated with sugar, chocolate, or gelatin to cover up any disagreeable odor and taste and to preserve them. Or, they may be coated with keratin, salol, or a resinous substance to prevent the pill dissolving until it reaches the intestines. Formerly pills were coated by slightly dampening the well-rounded pills with a little syrup and mucilage of acacia and putting them into a hollow sphere with silver leaf or gold leaf and rotating them. Pills can be coated at the prescription counter by moistening them with a little syrup and rolling them in a warmed dish containing confectioners' sugar, but the result is not very satisfactory. On a large scale the pills are put into a double walled, steam-heated revolving kettle with syrup or syrup and mucilage of acacia, and kept moving while the water is drying out of the syrup. The pills are then polished by attrition, frequently with paraffin. At the prescription counter the pills can be coated with gelatin by impaling them on needles and dipping them into a hot solution of 2.5 parts of gelatin, 7 parts of water, and 2 parts of mucilage of acacia, then revolving them in various directions until the coating sets. The needle hole is closed by touching it with a little hot gelatin solution. Various forms of apparatus are used for impaling and dipping the pills, but in large laboratories a different apparatus is used. The pills are put into a thin-bottomed drawer having a row of holes near the front just large enough for one pill in a hole. These holes correspond with cup-shaped cavities a little smaller than the pill in a long brass tube. The tube is placed beneath the drawer, so that the holes coincide, and pills are brushed so that one falls into each hole, resting in the cup-shaped cavity of the tube. Suction is applied to the tube and the pills are held to the tube by the pressure of air so that the tube can be turned over and the pills dipped into a hot gelatin solution, by which about one-half of the pill is coated. The tube is turned up with the pills on top, suction is removed and the pills passed through a drying oven to the other end of the machine. Another tube with cup-shaped cavities down is placed so that the coated part of the pills fit into the cavities, suction is applied to the tube and the second half of the pills is dipped into the gelatin, completing the coating.

Keratin, salol, or resins do not dissolve in the acid secretion of the stomach, but do so in the alkaline fluids of the intestine, so that they can be used for coating pills when it is desired that the pill shall not dissolve in the stomach. Keratin is a substance obtained from horny matter by treating with ether, digesting with pepsin and hydrochloric acid to get out the digestible matter, then washing with water, drying, and dissolving in ammonia water or in glacial acetic acid. Pills are dipped into this solution. Keratin is not much used. Salol is more frequently used, and the pills can be dipped into melted salol, or rotated in a dish with salol which has been melted on the water-bath and cooled nearly to the solidifying-point. Several coatings can be applied if necessary. The National Formulary (page 166) gives some directions for coating pills.

COMMENTS

Pilulæ Aloes. In making these pills, as well as all pills containing soap, care must be taken not to get in too much water; a little should be added at a time with considerable trituration.

Pilulæ Catharticæ Compositæ. The mass should be made up as stiff as possible, as these pills on drying shrink more than most pills and become dimpled.

Pilulæ Ferri Carbonatis, *Blaud's, Chalybeate, or Ferruginous Pills.* Reaction takes place between the two salts.

$$\underset{\substack{\text{Ferrous}\\\text{sulphate}}}{FeSO_4\cdot 7H_2O} + \underset{\substack{\text{Potassium}\\\text{carbonate}}}{K_2CO_3} = \underset{\substack{\text{Ferrous}\\\text{carbonate}}}{FeCO_3} + \underset{\substack{\text{Potassium}\\\text{sulphate}}}{K_2SO_4} + \underset{\text{Water}}{7H_2O}.$$

Sugar and glycerin retard the oxidation of the ferrous iron. Glycerin and water should be used sparingly, as water of crystallization in the ferrous sulphate is liberated and makes the mass softer. The U. S. P. allows the use of sodium carbonate in place of the potassium salt, but in smaller amount. These pills when first made have a dark green color, but the outside changes to a brown, due to oxidation to a ferric compound. The pills are rather large.

Pilulæ Ferri Iodidi. Ferrous iodide is easily oxidized, consequently an excess of metallic iron is used to prevent liberation of iodine, and the pills are coated with tolu. A solution proposed by Dunning of 5 Gms. of tolu dissolved in 15 mils of alcohol and 5 mils of ether added is preferred to the U. S. P. solution by some.

$$\underset{\text{Iron}}{Fe} + \underset{\text{Iodine}}{2I} = \underset{\substack{\text{Ferrous}\\\text{iodide}}}{FeI_2}.$$

Pilulæ Phosphori. Since phosphorus ignites in the air, it is necessary to cut and weigh it under water. Instead of doing this, it is quite common to use the corresponding amount of spirit of phosphorus or a mixture of phosphorus and resin. Chloroform is directed as the solvent because it is one of the best, and the vapor protects the phosphorus while being mixed with the other ingredients. By having phosphorus in solution it is more thoroughly distributed. A coating is necessary to prevent oxidation. Each pill contains about $\frac{1}{100}$ grain of phosphorus.

Pilulæ ad Prandium, *Dinner Pills,* N. F. The N. F. gives several formulas for "dinner pills," aloes being an ingredient in all. All of these pills are purgative in action. Attention is called to the large number of N. F. pills which contain aloes or aloin.

Pilulæ Aloes et Ferri. As made by this formula the pills are large and rough. Confection of rose may be drier than it should be, and too much used. Some excipient other than aromatic powder and confection of rose would be better. The dried ferrous sulphate is less bulky than the crystallized.

Pilulæ Aloini, Strychninæ et Belladonnæ, N. F. The formula makes a very small pill, and some powder or bulky excipient should be used, and also in the compound aloin, strychnine, and belladonna pills.

Pilulæ Antiperiodicæ, *Warburg's Pills,* N. F. These pills contain about the same ingredients as the antiperiodic tincture, except that the tincture also contains pepper, cinnamon, and ginger.

Pilulæ Catharticæ Vegetabiles, N. F. Like the compound cathartic pills of the U. S. P., these shrink on drying and the mass should be as stiff as possible. These pills can be used where there is an objection to taking mercury, the resin of mandrake acting much like calomel.

Pilulæ Glycerylis Nitratis, *Pills of Glonoin,* N. F. While nitroglycerin is explosive, the 1 per cent spirit is not dangerous. Each pill contains $\frac{1}{100}$ grain of nitroglycerin.

Pilulæ Opii et Plumbi, N. F. In massing these ingredients the sulphuric and meconic acids in opium combine with lead to make the insoluble lead sulphate and meconate.

MASSES

A pill mass is sometimes kept on hand ready to be rolled into pills quickly, using the amount wanted by the prescriber. The U. S. P. recognizes only two, but it is sometimes advantageous to keep on hand the ingredients, either in the form of powder or mass, of a particular prescription which a physician prescribes frequently.

COMMENTS

Massa Ferri Carbonatis, *Vallet's Mass.* Ferrous salts are oxidized to ferric by oxygen of the air and by light. To prevent or retard this oxidation ferrous sulphate is dissolved in boiling water from which dissolved oxygen has been driven off. For the same reason syrup is added to the iron solution, the solution is cooled before adding to the carbonate, the bottle is filled with water—excluding the air—and corked, the precipitate is washed by decantation with water containing syrup, and sugar and honey are added to the washed precipitate. Pure ferrous carbonate is white, but in this case there is some ferrous-ferric compound which is dark green. The finished mass is too thin to make into pills without a drying powder, and sometimes it is almost liquid. It should be protected from light.

$$\underset{\substack{\text{Ferrous}\\\text{sulphate}}}{FeSO_4} + \underset{\substack{\text{Sodium}\\\text{carbonate}}}{Na_2CO_3} = \underset{\substack{\text{Ferrous}\\\text{carbonate}}}{FeCO_3} + \underset{\substack{\text{Sodium}\\\text{sulphate}}}{Na_2SO_4}.$$

Massa Hydrargyri, *Blue Mass, Blue Pill.* This formula differs from that of the U. S. P. VIII in that it contains 1 per cent of oleate of mercury, which is added to help break the mercury into very fine globules. Metallic mercury when finely divided has a slate-blue color from which the preparation gets the name blue mass or blue pill. Mercury slowly changes to the black mercurous oxide, but there should not be more than a slight amount of this present.

Massa Copaibæ, *Solidified Copaiba*, N. F. Magnesium oxide combines with resin of copaiba, making a compound which dissolves in the oil of the oleoresin and which solidifies the oil. White particles of magnesium oxide should entirely disappear, and to get this result several hours of heating is necessary instead of the half-hour directed. This clear brown mass is too soft to make pills without some drying powder.

CONFECTIONS

Confections are aromatic masses or thick fluids in which some medicinal agent is mixed with honey, sugar and water, fruit-pulp (currants, figs, prunes, etc.), or similar substance, and intended to be eaten or dissolved in the mouth. The terms conserve and electuary are used synonymously with confection, although formerly a conserve was a confection in which the medicinal agent was in a fresh, moist condition, while an electuary was a confection in which the medicinal agent was previously dried. Confections are rarely used now, troches having displaced them. They are not recognized by the U. S. P. The N. F. gives formulas for two—rose and senna.

TROCHES

Troches or lozenges are small masses made from sugar with gum or other adhesive matter, and contain a medicinal or flavoring agent. The common form is disk-shaped, although squares, ovals, polygons, rods, and other forms are used. The usual weight is 10 to 20 grains, but the N. F. troches are all about 15 grains. They are generally intended to be dissolved in the mouth for local effect. Very finely powdered sugar is mixed with the medicinal or flavoring agent, then with the adhesive material, and made into a mass somewhat softer than that for pills. If acacia is used it is generally put in dry and water added, but with tragacanth the mucilage is better. The mass is rolled out on a lozenge board, glass plate, or marble slab, with a rolling pin, using guides to make it the right thickness. To prevent the mass from sticking to the board, it is dusted with sugar or preferably potato starch. Potato starch does not stick together as much as corn starch. Other powders, though not as good, may be used, but they should have the same color as the lozenge mass. The troches are spread out in a single layer in a shallow drawer and placed in a current of warm air to dry. A good dough for flavored troches or medicinal troches, where the amount of medicinal matter is small, can be made by mixing nine pounds of sugar, one pound of syrupy glucose, and sufficient mucilage of tragacanth.

If the lozenges are to be plain, without any character on them, the cutter is often a slightly conical tube with the cutting edge at the smaller end. Without stopping to remove each lozenge as it is cut, the cutter is filled; the tube increasing in size allows the lozenges to push up without binding. If an imprint or character is to be made on the lozenge, a cylindrical cutter is used with a plunger and on the end of the plunger the reverse of what is wanted on the lozenge. In this case each troche must be ejected as cut. Formerly troches were cut by hand, but a machine can now be obtained. The retail pharmacist rarely has occasion to make troches, but when he does, he can roll out the mass into a rod like a pill mass, cut it into the proper number of pieces, roll these into spheres and then flatten.

Pastils. Pastils are troches made from gelatin or chocolate, usually the former. Several formulas are used, but the gelatin may be softened and dissolved in two and one-half parts of water and the same amount of glycerin with the aid of heat. The medicinal matter is incorporated, and the mass poured into molds or pans, allowed to cool, and then cut into pieces.

Fumigating pastils are little cone-shaped masses made up of some balsamic substance mixed with charcoal and are intended to be burned to give a pleasant odor, and sometimes to act as a disinfectant.

Lamels are very small disks of gelatin with glycerin containing a medicinal agent. They are intended to be dropped into the eye, or used in making hypodermic solutions.

Bacills are troches in the form of short rods.

COMMENTS

Trochisci Carbonis Ligni, N. F. It is a generally recognized fact that charcoal after it has been wet does not absorb much gas, and as these troches are largely used for flatulence they can be of little service.

Trochisci Phenolphthaleini, N. F. This is a formula not previously given. Phenolphthalein is colored red by alkalies, even the saliva. The troches are colored with carmine so that those who are not acquainted with this agent will not notice any change in color.

Trochisci Quininæ Tannatis, N. F. Although quinine is present, these troches are practically free from bitterness because quinine tannate is practically insoluble. It is unquestionably much less active therapeutically than the soluble salts. Chloroform is used to bring the oil and alkaloid into more intimate mixture. Saccharin, vanillin, and cocoa are used to cover up the bitter taste which otherwise might be noticed.

Trochisci Santonini, N. F. Santonin turns yellow slowly in diffused light, but quickly in direct sunlight, and any troches containing it which are white should be kept in the dark. In this formula the cocoa gives a color which prevents any change from being noticed.

COMPRESSED TABLETS

Definition. A compressed tablet is a solid preparation made by compressing one or more medicinal substances. The shape may be round, square, oval, or other form, with a flat or more frequently convex upper and lower surface. They are from $\frac{1}{8}$ to $\frac{3}{4}$ inch in diameter. The medicinal agent may be compressed alone, or it may be diluted or mixed with other agents in order to get it into proper condition for compressing. Some are intended to be held in the mouth until dissolved, while others are to be swallowed whole, and these may be coated with sugar or chocolate.

Agents that are likely to change in the air or that are volatile should not, as a rule, be made into compressed tablets. If a volatile oil is to be used as a flavor, one like wintergreen, cloves, or cinnamon, should be chosen which is not very volatile and does not change readily as lemon and orange do. Tinctures and fluidextracts should be evaporated to soft solids and mixed with a drying powder. Alkaloids and other active principles should be mixed with sugar of milk or other inert powder.

Granulating. A few chemicals require no treatment, as ammonium chloride or potassium chlorate. Most agents must be granulated, because fine powders do not feed well or evenly into the compressor, and the particles hold air between them so that a perfect tablet cannot be made. Methods of granulating must vary with the material. In case of crystalline salts, they can often be bought in a granulated condition, or if in large crystals they can be coarsely ground and passed through a No. 12–20 sieve. Or they can be granulated by evaporating a solution while stirring, breaking up the larger masses. When several ingredients are to be put into a tablet, it is necessary to powder each separately, mix thoroughly, and granulate. The mixture of powders is dampened with water, alcohol, syrup, glucose, mucilage of tragacanth, or, to the mixture of powders, some sugar, acacia, dextrin, flour, or similar powder is added and then water. The dampened mixture is passed through a No. 12–20 sieve and the granules dried. If left damp the granules will probably not feed well and will stick to the punches. The particular liquid or adhesive agent to be used varies with the medicinal agents. Light bulky powders are usually mixed with quite a percentage of sugar.

In compressing some insoluble compounds, as acetanilid or salol, the tablet produced is not dissolved or disintegrated in the body. To overcome this fault, freshly dried starch is added just before compressing, using from 10 to 15 per cent. Dried starch absorbs moisture, swells, and aids the rupture of the tablet. Sodium bicarbonate is sometimes put in, and this with the acid of the gastric juice causes disintegration, or, an acid may be put in with the bicarbonate. In making an effervescing tablet, the acid and bicarbonate are granulated separately and the granules mixed. If two salts are to be used which are capable of reacting and liberating water of crystallization, the water should be driven off first.

Some salts or mixtures do not feed well, and stick to the punches or mold. To relieve this trouble a lubricant may be used, such as talc (not over 3 per cent), boric acid (not over 2 per cent), starch, lycopodium, cacao butter, petrolatum, or liquid petrolatum. Talc is most commonly used with insoluble powders and boric acid with soluble ones. In using liquid petrolatum, it is best sprayed on to the granules with an atomizer; some prefer to first dissolve it in ether and then spray, but the ether solution is more liable to penetrate the granules. About 50–60 minims of liquid petrolatum are used for a pound of granules.

Machines. Machines for making compressed tablets vary greatly in price as they do in size, but they operate on about the same principle, by pressing the granules between two punches in a mold. The machine is generally equipped with several different sizes of molds. By regulating the lower punch the amount of material or weight of tablet is regulated, and by adjusting the upper punch the amount of pressure is determined. The mold and punches must be kept smooth and polished, and the edges of the punches sharp, otherwise the tablet may be imperfect and stick. After using, the punches and molds should be thoroughly cleaned and oiled.

The pressure should be carefully regulated. If it is too great the tablets do not readily disintegrate and are apt to chip. Or if the pressure is not sufficient, the tablets crumble. It should be such that the tablets will not be crushed by ordinary handling, but can be broken in the fingers.

In making compressed tablets of potassium chlorate the salt should not be mixed with organic or reducible matter; even dust mixed with it has been known to cause explosion in compressing.

COMMENTS

Toxitabellæ Hydrargyri Chloridi Corrosivi. The prefix "Toxi" in the Latin name seems unnecessary. The U. S. P. requires these tablets to be angular, stamped with the word poison and design of scull and crossbones, and to be colored blue, all of which is to call attention of the user to the fact that the tablets are poisonous. Sometimes they are made in the shape of a coffin. Blue color is chosen because foods and drinks are not often colored blue, and the uncommon color would catch the eye at once.

TABLET TRITURATES

As the name implies, tablet triturates are tablets made from triturations. They are made by pressing a properly dampened trituration into holes in a hard rubber plate, the plate containing from 50 to 100 holes. Another plate having pins to fit the holes is used to force out the tablets, after which they are dried. Only enough pressure is used to fill up the holes. These tablets are not as hard as compressed tablets, and dissolve much more quickly. They usually weigh between 1 and 2 grains. In cleaning the mold hot water should not be used because of danger of warping it. Until recently tablet triturates were made by hand, but a machine can now be obtained.

The diluent used in making the trituration is sugar of milk, cane sugar, or a mixture of the two. Cane sugar makes a more soluble tablet and also a harder one. For easily reducible substances, as silver nitrate or potassium permanganate, kaolin or some such substance should be used. After reducing all ingredients to very fine powders and thoroughly mixing, the mixture is dampened usually with water, alcohol, or water and alcohol. If the diluent is sugar of milk a larger proportion of water can be used than if cane sugar is the diluent. Only a sufficient amount of liquid is used to make a damp powder or crumbly mass. If too much is used, the tablets will be too hard to dissolve readily, or if too little liquid is used the tablets will crumble. Tablet triturates can easily be made at the prescription counter. The amount of diluent for any given formula must be worked out experimentally with the mold at hand.

HYPODERMIC TABLETS

These are similar to tablet triturates, but must contain only soluble ingredients, must be porous and friable, and must dissolve quickly. The diluent generally used is pure cane sugar, milk sugar, or sodium sulphate. They should be small enough to slip into the barrel of a hypodermic syringe.

TABLET SATURATES

Tablet saturates are tablets or pellets made of milk sugar or cane sugar which are saturated with a tincture or alcoholic solution of the remedy, and the excess of liquid removed. These are more largely used by the homœopathic school of physicians than others. Orbicules are similar, but the pellets of sugar are flattened on one side.

LIQUID PREPARATIONS CONTAINING UNDISSOLVED MATTER

MIXTURES

Definition. In the broad sense of the word, a mixture is the result of the incorporation of two or more substances. In the restricted sense in which it is used to designate a class of preparations, it has been defined as a preparation in which an insoluble substance is held in suspension in water. However, one of the two U. S. P. mixtures and several of the N. F. mixtures are practically solutions with only a slight amount of inert matter held in suspension. Some of the N. F. mixtures are emulsions. There is but little difference between mixtures and emulsions, but usually in mixtures the insoluble substance is a solid and in emulsions it is a liquid or resin. A mixture should be dispensed with a " shake well " label.

Suspending Agents. When an insoluble solid is to be suspended in water, it is generally best to rub it with a small amount of water to wet it thoroughly. In many cases it is best to mix the solid with some acacia or tragacanth before adding the water. Some powders repel water, and if just shaken with water they cake. Sometimes it is better to rub the powder with sufficient glycerin to make a mass, before adding water. When tragacanth is used care should be taken not to use too much, about one-eighth as much as acacia. Some pharmacists in using tragacanth prefer to mix it with the insoluble substance first and then dampen it with a little alcohol before adding water. In case of magnesium oxide a considerable excess of water should be added at once, otherwise the hydroxide formed will be in hard granules or masses.

In making mixtures where two or more solutions are mixed and an insoluble compound is formed as the result of chemical action, the precipitate is more bulky and easy to suspend if cold, dilute solutions of the reacting agents are made before mixing. The precipitate is also more easily suspended if it has not been previously dried. Sometimes by highly diluting the reacting agents or adding a liquid as syrup or glycerin, precipitation can be prevented.

COMMENTS

Mistura Cretæ, *Chalk Mixture.* Compound chalk powder contains prepared chalk, acacia and sugar. Prepared chalk, although not as pure as precipitated calcium carbonate, is smoother, less gritty, and less crystalline. Acacia aids the suspension of chalk by making the liquid thick and viscid. Sugar sweetens the preparation and makes the liquid thicker. This preparation must be made up fresh when wanted, as it quickly spoils, acquiring a disagreeable odor and taste in a few days. The acid formed by fermentation liberates carbon dioxide from the chalk and the gas may burst the bottle.

Mistura Glycyrrhizæ Composita, *Brown Mixture.* This is practically a solution, as inert matter from the extract with a little matter from paregoric is all that is precipitated. It would be about as active and would have a better appearance if it were filtered.

Mistura Adstringens, *Villate's Mixture,* N. F. There is sufficient acetic acid to convert the lead subacetate into the normal acetate. The lead is practically all precipitated as the sulphate.

$$\underset{\text{Lead subacetate}}{Pb_2O(C_2H_3O_2)_2} + \underset{\text{Acetic acid}}{2HC_2H_3O_2} = \underset{\text{Lead acetate}}{2Pb(C_2H_3O_2)_2} + \underset{\text{Water}}{H_2O}.$$

$$\underset{\text{Lead acetate}}{Pb(C_2H_3O_2)_2}+\underset{\text{Copper sulphate}}{CuSO_4}=\underset{\text{Lead sulphate}}{PbSO_4}+\underset{\text{Copper acetate}}{Cu(C_2H_3O_2)_2}.$$

$$\underset{\text{Lead acetate}}{Pb(C_2H_3O_2)_2}+\underset{\text{Zinc sulphate}}{ZnSO_4}=\underset{\text{Lead sulphate}}{PbSO_4}+\underset{\text{Zinc acetate}}{Zn(C_2H_3O_2)_2}.$$

Mistura Chloralis et Potassii Bromidi Composita, N. F. The extracts of cannabis and henbane are resinous, and are rubbed with pumice to enable the liquid to dissolve them better. The pumice is later filtered out, and with it the insoluble matter. A strong solution of hydrated chloral dissolves the extracts, and there is but little precipitation on adding the balance of the water.

Mistura Copaibæ, *Lafayette Mixture,* N. F. Copaiba is an oleoresin (resin dissolved in oil). The resin is partly converted into a soap by potassium hydroxide, and the soap helps to keep the ingredients mixed. Mucilage of acacia also helps to maintain a homogeneous mixture.

Mistura Ferri Composita, *Griffith's Mixture,* N. F. Two chemical reactions occur:

$$\underset{\text{Potassium carbonate}}{K_2CO_3} + \text{Resin (in myrrh)} = \text{Resin soap.}$$

$$\underset{\text{Potassium carbonate}}{K_2CO_3} + \underset{\text{Ferrous sulphate}}{FeSO_4} = \underset{\text{Ferrous carbonate}}{FeCO_3} + \underset{\text{Potassium sulphate}}{K_2SO_4}.$$

Ferrous carbonate, if perfectly pure, is white, but in this case it is dark-green because it is a mixture of ferrous and ferric salts, commercial ferrous sulphate always containing some ferric compound. On exposure to direct sunlight this mixture soon acquires a dirty yellowish-brown color due to the oxidation of the ferrous iron to the ferric condition (largely ferric oxide). The sugar used retards this change. The insoluble ferrous carbonate is held in suspension by the gum in the myrrh and by the resin soap formed.

Mistura Guaiaci, N. F. Tincture of guaiac is very resinous. The cinnamon water precipitates the resin which would form masses and stick to the sides of the bottle if it were not for the honey. Honey does not prevent precipitation, but the precipitate does not stick in masses or to the bottle, and can be evenly distributed on shaking.

Mistura Opii et Sassafras, *Godfrey's Cordial,* N. F. Potassium carbonate liberates the alkaloids from their combination with acids in the opium, but most of the alkaloids remain in solution. The small amount of alcohol used is to cut the oil.

Mistura Pectoralis, Stokes, N. F. Ammonium carbonate, although used for its therapeutic action, tends to prevent some precipitation from the fluidextracts. Some ammonia water is used in making fluidextract of senega. Water and syrup precipitate some of the ingredients from paregoric.

Mistura Rhei Alkalina, *Neutralizing Cordial,* N. F. Potassium carbonate in this mixture, and sodium bicarbonate in the compound rhubarb mixture, are put in for their therapeutic effect, but both help to prevent precipitation of resinous matter from the fluidextracts.

EMULSIONS

Definition. An emulsion is a preparation which contains an oil or other immiscible liquid, or a resin or similar solid held in suspension in water by means of a suspending agent. Emulsions are quite similar to mixtures except that mixtures contain solids other than resins, fats, waxes, and like substances. There are a number of natural emulsions, as milk, yolk of egg, and milky juices of plants. Milk is referred to as the type of emulsions. Butter-fat is held in suspension by casein, and although cream separates from the watery part, the two can be readily mixed. In case of gum-resins or oil-seeds, the suspending agent is present naturally, and all that is necessary is to triturate them with water. Most emulsions used in medicine are made artificially, and of these the oil emulsions are the most common.

Emulsifying Agents. An emulsifying agent is a substance which keeps insoluble matter in suspension. As Scoville (Art of Compounding, page 104), has so aptly said, " What tact is to society, the emulsifying agent is to the emulsion. It introduces the antagonistic bodies, overcomes their antipathies, brings them into intimate contact, and holds them in harmony." The theory is that emulsifying agents form a film around the little globules of oil, preventing them from coalescing; the liquid is made more viscid, which tends to make the globules of oil and water adhere. The agents are generally gummy, mucilaginous, albuminous, digestive, saponin-like bodies, or alkalies. Of these acacia is in many respects the best, and is the one most commonly used. It breaks up the oil into smaller globules, and because of this makes a whiter emulsion. It has the disadvantage that an emulsion made with it will often separate into two layers, and also that acacia is precipitated or coagulated by alcohol and by quite a number of salts and compounds which may be added. The separation may be largely overcome by using acacia to make the primary emulsion, and then a little tragacanth. Acacia when dissolved in water increases the number of milliliters of the liquid about two-thirds of the number of grams of acacia used.

Tragacanth does not break up the oil into as small globules as acacia, and does not make as white an emulsion, but it makes a more viscid liquid which retards separation. A much smaller amount of tragacanth than acacia is used, about one-eighth or one-tenth as much. The emulsion stands but little dilution without cracking. Irish moss is similar to tragacanth in not making a white emulsion, but is used to some extent on account of its cheapness. Like tragacanth, it requires long agitation to make a good emulsion. Dextrin has no advantage, and is not satisfactory. If extract of malt is prescribed in an emulsion, it can be used as the emulsifying agent after neutralizing the acid in it.

Casein is obtained from milk by first removing fat and then precipitating with an acid. Some commercial emulsifiers contain it as one of the ingredients. Condensed milk with an equal volume of water may be used. Yolk of egg is good for emulsifying oils or liquids hard to emulsify. Gelatin is said to be particularly good for petroleum products. Pancreatin digests fixed oils to some extent, and in that way may act as an emulsifier. Emulsions made with albuminous agents and fixed oils do not keep well, and must have a preservative if they are not used up in a reasonable time. Volatile oils are preservative in themselves.

Solutions of saponin-like principles, as tincture of soap bark, senega, or sarsaparilla, are very effective emulsifiers. They are particularly good for volatile oils and liquids hard to emulsify, and the emulsion is not easily cracked by the addition of acids, salts, or alcohol. This class of emulsifiers should not be used without the physician's knowledge, as they have an acrid, irritating effect. Soap is a good emulsifier, but should not be used for internal preparations; it is used for " dips " and insecticide sprays. A strong solution of soft soap is quite effective as a solvent for many liquids which are immiscible with water, and this solution mixed with water makes an emulsion. An example of this is found in the compound cresol solution.

Methods of Making. There are two general methods of making emulsions—to mix the oil and acacia together and add water, or to make a mucilage and add the oil slowly to it. The first method is generally the most satisfactory, and forms an emulsion quickly. Certain precautions must be taken. The rule for fixed oils is to use 4 parts by volume of oil, 1.5 to 2 parts by volume of water, and 1 part by weight of acacia. The proportion of water and acacia must be kept within these limits, but the proportion of these to the oil may be varied in quite wide limits without danger of getting a cracked emulsion. The mortar must be dry, the oil measured in one graduate and the correct amount of water in another; there must not be a drop of oil in the water or a drop of water in the oil; have the powdered acacia weighed out. Into the mortar put the oil and then the acacia and mix thoroughly and quickly. As soon as possible add the water all at once and stir rapidly and continuously. In stirring, pressure is not wanted, but rapidity is. If an emulsion is not made within five minutes of stirring it will probably not form, and will have to be treated as given later. This primary emulsion can be diluted with the required amount of syrup or water, being careful to add the liquid slowly with stirring, for if added too fast the emulsion may crack. The oil and acacia must not stand together any longer than absolutely necessary before adding the water, and the mixture should not be stirred while pouring in the water. A glass mortar should not be used because it is too smooth, the mixture slipping around in it. This method is practically limited to the use of acacia as the emulsifier.

In the second method the emulsifying agent is first made into a liquid; in case of acacia, tragacanth, or Irish moss, a mucilage is made. It is put into a mortar, the oil added a few drops at a time and thoroughly emulsified before adding more. The great danger is in adding the oil too fast. After the emulsion is made it can be diluted as desired.

Fixed oils are comparatively easily emulsified. Volatile oils, ether, chloroform, creosote, and similar liquids are harder to emulsify, and often require more acacia, sometimes one-half to an equal amount of acacia as liquid. The U. S. P. uses 15 Gms. of acacia for 15 mils of oil of turpentine. The addition of a fixed oil, as olive oil or expressed oil of almonds, to the volatile liquid makes a better and more permanent emulsion. Emulsions of volatile liquids are often more easily made by shaking in a bottle than stirring in a mortar, the emulsion being thinner. Gum-resins and seeds contain the necessary emulsifying agent, and trituration with water is all that is necessary. Seeds contain albuminous matter which acts as an emulsifying agent. Tears or masses of gum-resins should be used in preference to powders, because powders are weaker therapeutically on account of volatilization or oxidation of active principles, and because the gum is less soluble. Wax, spermaceti, and similar solids must be melted before emulsifying. Flavoring agents can be added to the primary emulsion or to the oil to be emulsified. The N. F. (page 43), gives a list of combinations of flavors. If a prescription calls for a double emulsion, as a seed and an oil emulsion, it is better to emulsify them separately and then mix.

Soluble salts are sometimes prescribed with emulsions. If the amount of water allows it, they should be dissolved in the water not used in making the primary emulsion, and then added slowly, as salts tend to retard the making of the emulsion or to crack it. If alcoholic preparations, as spirit of nitrous ether, are to be added to emulsions, they should be diluted as much as possible with water and then added slowly to the primary emulsion. Strong alcohol prevents emulsification or cracks emulsions by precipitating the emulsifier. Heat, freezing, and, in some cases, excessive trituration, crack emulsions. A cracked emulsion is one in which the oil separates in globules or a layer. Many emulsions separate into two layers just as cream separates from milk, but they are not cracked, the fat being still emulsified; a little agitation is all that is necessary to mix the layers. The finer the globules of oil, the less liability will there be of separation into layers. If an emulsion is cracked in making, it can often be remedied by making a fresh mucilage of acacia and adding the thoroughly mixed cracked emulsion to it slowly as oil would be added in the second method mentioned. The product is not as good as though it had been properly made at first.

Preservation. If an emulsion is to be bottled and kept in stock for some time, a preservative may be necessary to prevent decomposition. Volatile oils or volatile liquids are themselves antiseptics. Glycerin is the most commonly added preservative, being thick; it does not precipitate the emulsifier.

COMMENTS

Emulsum Amygdalæ, *Milk of Almonds.* Almonds are blanched by pouring hot water on them and then rubbing off the brown skin which has been loosened. By removing the brown membrane a whiter emulsion is made. Acacia and sugar are not necessary, but they make a more stable emulsion.

Emulsum Asafœtidæ, *Milk of Asafœtida.* Only a small amount of water should be added until the gum-resin is completely disintegrated. The emulsion is generally white, but later, it sometimes turns pink. This is probably due to oxidation of some constituent in the drug. It should never be made by adding a tincture to water.

Emulsum Petrolati, N. F. This frequently does not make a good emulsion, although expressed oil of almonds is used to aid it.

WATER AND GLYCERIN SOLUTIONS

WATERS

Definition. Into this class is generally put preparations made by dissolving a volatile substance in water. This substance may be a solid (as camphor), a liquid (as oil of cinnamon), or a gas (as ammonia). Two or three preparations which the U. S. P. puts into the class " solutions " more properly belong in the class " waters," as solutions of formaldehyde and compound iodine solution. Hydrogen dioxide, formerly classed with waters, is now official under solutions, as it is only slightly volatile. Ammonia, stronger ammonia, creosote, and witch hazel waters have some medicinal value, but the others are chiefly used as flavors. Flavoring waters are generally saturated solutions.

Methods of Making. Waters may be made by distillation, chemical action, simple solution, or simple solution with the aid of a third substance. Distilled water, witch hazel, stronger orange, and stronger rose waters are made by distillation, a method being given in the U. S. P.

for the first one only. Flavoring waters made by distillation from the plant are sometimes better than when made from the oil because the plant often contains other compounds, as esters and ethers, which go over with the oil and make the waters more pleasant. They may have a foreign disagreeable odor at first which is dissipated by exposure. Ammonia and stronger ammonia waters are made by chemical action and distillation. Bitter almond, orange flower, chloroform, creosote, and rose waters are made by simple solution. The others are made with talc.

In making several waters, the volatile substance is rubbed with talc, then with water, and filtered. The talc should not be so fine that it will pass through filter paper. Talc does two things: 1. It breaks up the oil into minute particles, increasing greatly the aggregate surface of the oil exposed to the solvent action of the water, so that the water becomes more readily saturated. 2. It removes the excess of oil, the globules of which may be so fine as to otherwise pass through the filter. If the filtrate comes through turbid or milky, it should be passed through the same filter once or twice, and if still turbid more talc should be used.

Purified talc is preferable to many other powders because it is insoluble in any fluid and is not affected by acids or alkalies. In place of talc the U. S. P. allows the use of kieselguhr, pulped paper, shaking the oil with hot water, distillation of the drug with water, or distillation of the oil with water. A general process is given in which two mils of oil are used in making a liter of water. In a previous pharmacopœia, oil was distributed through absorbent cotton, this placed in the neck of a funnel and water passed through, but frequently oil globules were washed through. Magnesium carbonate, which is sometimes used in place of talc, is a basic compound, is slightly soluble in water and makes the water sufficiently alkaline to cause precipitation when some metallic or alkaloidal salts are dissolved in it. Calcium phosphate is sparingly soluble in water, and a flavoring water made with it seems to be a better medium for the growth of microörganisms. Both magnesium carbonate and calcium phosphate are soluble in acids, and should not be used in filtering acid fluids.

Preservation. Flavoring waters sometimes develop microörganisms, and should be kept in well-stoppered bottles away from heat and light. They should be made with sterilized distilled water and put into sterile bottles. Heat and light tend to lessen the fragrance of the water. Alcohol in sufficient quantity to act as a preservative should not be used in flavoring waters, but it is used in witch hazel water, where it has some medicinal value.

COMMENTS

Water. Ordinary hydrant, river, or spring water contains dissolved oxygen, carbon dioxide, carbonate and sulphate of calcium, other salts, and often organic matter and microörganisms. Rain water, though containing less inorganic matter, contains ammonia, carbon dioxide, yeasts, molds, bacteria, and small particles of matter which were floating in the air. Boiling these waters improves them. Temporary hardness is due to calcium carbonate held in solution by carbon dioxide, and on boiling the carbon dioxide is driven off and the calcium carbonate is precipitated, rendering the water softer. Permanent hardness is generally due to calcium sulphate which is not removed by boiling.

Aqua Destillata. In making distilled water the U. S. P.

directs in starting with 1000 volumes, that the first 100 volumes of the distillate be thrown away, as it may contain ammonia and other gases. The last 150 volumes of water are left in the still to prevent damage to the still and to avoid decomposition and volatilization of solid matter. Condensed water from radiators or steam pipes is not satisfactory as a substitute for distilled water as it is liable to contain grease from the boiler and iron from the pipes. Only water that has been distilled should be used in filling prescriptions and in making most preparations. Even this water frequently contains small amounts of ammonia. Glass or block-tin condensers should be used, as pure water dissolves traces of iron or lead.

Aqua Destillata Sterilisata. The flask should be of hard glass, as soft glass dissolves sufficiently to make the water slightly alkaline. Jena glass is good. The flask is closed by a pledget of cotton because cotton allows the passage of vapors and air but not of bacteria and microörganisms. Sterilized water should be used for all hypodermic solutions.

Aqua Ammoniæ. Aqua Ammoniæ Fortior. Ammonia water and stronger ammonia water are usually made by heating an ammonium salt with milk of lime and passing the gas into water.

$$\underset{\substack{\text{Ammonium}\\\text{chloride}}}{2NH_4Cl} + \underset{\substack{\text{Calcium}\\\text{hydroxide}}}{Ca(OH)_2} = \underset{\text{Ammonia}}{2NH_3} + \underset{\substack{\text{Calcium}\\\text{chloride}}}{CaCl_2} + \underset{\text{Water}}{2H_2O}.$$

Attention is called to the U. S. P. directions for keeping these waters, particularly the stronger, in partly filled bottles to avoid danger of liberation of sufficient gas to burst the bottle. Gas can be compressed much more readily than a liquid, and this is allowed for by having the bottles only partly full. Care should be taken in opening a bottle of strong ammonia water to avoid the gas under pressure from blowing into the face. Ammonia water after standing for some time will have shining particles of silica in it. These can be filtered out and the water is all right to use provided it has the required strength. Ammonia water should be frequently tested for strength.

Aqua Amygdalæ Amaræ. Bitter almond water contains 0.1 per cent of oil. The hydrocyanic acid content of the U. S. P. oil of bitter almonds varies from 2 to 4 per cent. As the water is used for its flavor and the hydrocyanic acid is present in such small amounts, it is of but little consequence whether the natural or the artificial oil (benzaldehyde) is used. The oil is more soluble in water than most oils, and a solution as strong as desired can be made without the use of talc.

Aqua Aurantii Florum Fortior. Aqua Rosæ Fortior. These waters sometimes acquire a disagreeable odor if kept tightly stoppered. This odor can be dissipated by leaving the stopper out of the bottle part of the time. The U. S. P. directs that the bottles be stoppered with cotton to prevent this odor. Both of these waters are obtained as by-products in the distillation of the oils. Orange flower water and rose water are better when made from the stronger waters than when made from the oils.

Aqua Camphoræ. Camphor is hard to powder alone, but is easily powdered in the presence of alcohol. After mixing with talc, the alcohol is evaporated before adding water so that the finished product will not contain too much camphor.

Aqua Chloroformi. The U. S. P. directs "chloroform, distilled water, each a sufficient amount." Chloroform is volatile and in water solution exposed to light, it is decomposed with the formation of hydrochloric acid, consequently an excess is used to keep the water saturated at all times.

Chloroform is soluble in about 210 volumes of water, so that the saturated solution contains about 0.5 per cent by volume. In using this water the container should not be shaken; only the saturated water is wanted. This water is good to disguise the taste of saline salts.

Aqua Cinnamomi. Oil of cinnamon is chiefly cinnamic aldehyde, which slowly oxidizes to cinnamic acid, causing the water to become acid.

Aqua Hamamelidis, *Witchhazel Water.* The directions of the U. S. P. VIII did not give a water corresponding to the commercial distilled extract. The fresh parts of the shrub are now used in place of the dried bark. Alcohol is added as a preservative and for its therapeutic effect.

INFUSIONS

Definition. An infusion is an aqueous preparation made by extracting a drug with cold or hot water. Cold water is used if heat injures the active principle, as in wild cherry, but in most cases boiling water is poured on the drug. Such drugs as leaves and soft parts of plants are suitable for making infusions. Rain water or distilled water makes a better infusion than hard water. Earthen vessels are better for making infusions than metallic ones, because they keep the heat longer and there is no danger of tannic acid attacking iron and discoloring the preparation. An infusion mug usually has a perforated diaphragm in the upper part of it on which the drug rests; enough water must be used to cover the drug, which is exhausted by circulatory displacement. The general formula directs that 5 grams of drug be used in making 100 mils of infusion. Infusions should not be made by diluting fluidextracts, as the fluidextract does not contain the same active principles as the infusion properly made. This is particularly true in case of digitalis. Infusions should be strained but not filtered, consequently they are frequently not clear. They do not keep well, and should be made up as needed.

Species, often called teas, are bruised or coarsely ground vegetable drugs, generally made into a hot infusion and used in domestic practice. The N. F. gives formulas for three, one of which (emollient species) may be used as an emollient poultice.

COMMENTS

Infusum Digitalis. Digitalis is a comparatively active drug, and, following the U. S. P. directions, the infusion is less than one-third as strong as infusions made by the general formula. About 10 per cent of alcohol was formerly used to preserve it.

Infusum Sennæ Compositum. Compound infusion of senna is frequently called " black draught." This synonym should not be used on account of danger of confusing it with " black drop," which is vinegar of opium.

Infusum Cinchonæ, N. F. Aromatic sulphuric acid is used to aid solution of the alkaloids.

Infusum Gentianæ Compositum, N. F. Gentian yields its active principles to water, but the mixture of drugs is percolated with dilute alcohol to get out the aromatics. The percolate is diluted with water so that it contains about 12 per cent of alcohol in the finished infusion.

Infusum Pruni Virginianæ, N. F. The bark is macerated with cold water for three hours to enable the ferment to decompose amygdalin, yielding benzaldehyde and hydrocyanic acid. If hot water were used the ferment would be coagulated and any aldehyde or acid formed would be volatilized.

DECOCTIONS

A decoction is an aqueous preparation made by boiling a drug in water. Putting on cold water first, extracts some principles which might not be taken out by hot water. Hard parts of plants such as roots, barks and woods are suitable for making decoctions. On account of the great amount of heat necessary, drugs containing volatile oils and easily decomposed principles are not suitable for making decoctions. The general formula directs that 5 grams of drug be used in making 100 mils of decoction. Decoctions spoil very quickly, but if proper precautions are taken they will keep longer than infusions, because the boiling sterilizes the preparation. The U. S. P. gives only the general formula, and the N. F. gives the formula for the compound decoction of sarsaparilla.

MUCILAGES

Mucilages are solutions or partial solutions of gummy substances in water. With the exception of mucilage of tragacanth, which contains glycerin, these preparations spoil quickly and should be made in small amounts only. While they may be used as demulcents, they are chiefly used to keep insoluble substances suspended in water.

COMMENTS

Mucilago Acaciæ. Acacia consists largely of calcium arabate, and yields an acid solution. Lime water was used in the U. S. P. VIII to neutralize this acidity. In making up considerable quantities of this mucilage the tears or granules, washed free from adhering impurities, are best suspended in a coarse cloth in the upper part of the warm water, so that as the gum dissolves the heavy solution will settle to the bottom, bringing a less saturated solution in contact with the gum. In making small amounts the mucilage can be more quickly made by putting powdered acacia into a mortar and adding enough water at once to make a thin mass or thick liquid, rubbing this up thoroughly until the gum is dissolved and adding the balance of the water in portions. If too much water is added at first, the powder forms masses that do not dissolve quickly and cannot be rubbed down because they slip from under the pestle. In dissolving acacia in water, the number of milliliters by which the liquid is increased is about the same as two-thirds of the number of grams of acacia dissolved. Thirty grams of acacia dissolved in thirty mils of water measure about fifty mils. If as much as three-fourths of its volume of alcohol is added to mucilage of acacia, the acacia is precipitated, consequently acacia is not a good suspending agent for strongly alcoholic preparations.

Mucilago Tragacanthæ. Only a part of tragacanth is soluble in water; the balance of it swells. After the twenty-four hour maceration, the mixture should be forced through a strainer several times to make it uniform. This is a gelatinous mass. Tragacanth is sometimes a better suspending agent than acacia, because it is not coagulated or precipitated by so many chemicals, and being used in much smaller amounts it is not as readily thrown out of solution. Tragacanth is used in making many toilet lotions.

Mucilago Chondri, N. F. Irish moss is washed with water to remove impurities, particularly salt. This mucilage varies considerably in thickness, depending upon the sample and the amount of pressure used in straining.

HONEYS

This is an unimportant class. In making clarified honey, shredded paper acts mechanically, carrying with it wax and other suspended impurities. Heating makes the honey thinner so that the impurities will rise. Glycerin is added as a preservative. Honey with vinegar is sometimes used in domestic practice for sore throat. Honey of rose is used as an astringent, as a flavoring agent, and in making mass of mercury. In the honey of borax, N. F., and the honey of rose and borax, N. F., borax is decomposed by glycerin, yielding sodium metaborate and boric acid, or, perhaps, sodium glyceryl borate and glyceroboric acid. The reactions are given under the compound solution of sodium borate. Glucose has a similar effect on borax. Instead of these honeys being alkaline from borax they are acid.

VINEGARS

Definition. Vinegars are solutions of active principles of drugs in dilute acetic acid, and of such strength that 10 mils represent 1 Gm. of drug. Dilute acetic acid contains 6 per cent of acid, and is a little stronger than ordinary vinegar. The U. S. P. recognizes only one.

COMMENTS

Acetum Scillæ. This is made by maceration and straining. The strained liquid is heated to boiling to coagulate albuminous matter which is filtered out.

Acetum Opii, N. F. This is known as " black drop," and should not be confused with " black draught," which is the compound infusion of senna. Vinegar of opium is of the same strength as laudanum, but no assay process is given.

GLYCERITES

Definition. Glycerites are solutions or partial solution of medicinal agents in glycerin. Glycerin is very hygroscopic, and all these preparations absorb moisture on exposure to air, but no decomposition takes place except in case of the boroglycerin.

COMMENTS

Glyceritum Acidi Tannici. The color differs in different samples on account of the variation in the acid. Heat is used to hasten solution. Iron utensils should be avoided, because tannic acid with iron makes the black tannate of iron. This is a convenient solution for dispensing or for diluting with water. The solution is thinner when warm, and can then be strained more easily.

Glyceritum Amyli, *Glycerite of Starch.* Starch is triturated with water to break up all lumps. The glycerin should not be too hot when the starch and water are added, because if it is the product will be lumpy and not homogeneous. A heat higher than that of a water-bath is necessary to dissolve the granules. If a thermometer is used, it must be remembered that the mass is very thick and the starch may burn, although the thermometer shows a temperature below 144° C. The glycerite should be translucent and not dark colored.

Glyceritum Boroglycerini. Heating causes chemical reaction and water is volatilized.

$$\underset{\text{Glycerin}}{C_3H_5(OH)_3} + \underset{\substack{\text{Boric}\\\text{acid}}}{H_3BO_3} = \underset{\substack{\text{Glyceryl}\\\text{borate}}}{C_3H_5BO_3} + \underset{\text{Water}}{3H_2O}.$$

In subsequently mixing with glycerin, however, some glyceroboric acid may be formed, particularly if a little water is present in the glycerin. When the water has been volatilized and the weight reduced to the required amount, the reaction is supposed to be complete. If glycerin which has absorbed water is used in making this preparation, the mixture of glycerin and acid is reduced to the proper weight before the chemical action is finished, and when the preparation becomes cold, boric acid often crystallizes out. Boroglycerin is a hard, tough solid when cold, and should be dissolved in the remaining glycerin while still warm. This glycerite should be put into a dry, well-stoppered container, because water causes the reverse reaction to take place, forming glycerin and boric acid.

Glyceritum Hydrastis. Golden seal is exhausted with alcohol, as it would be difficult if not impossible to percolate it with 50 per cent glycerin which makes up the finished product. After distilling off the alcohol the residue is poured into cold water to precipitate the resinous matter. The mixture is set aside for twenty-four hours to complete precipitation and to allow the particles to agglutinate so that they can be filtered more readily. This preparation is weaker than the fluidextract because some of the alkaloids are precipitated and lost with the resinous matter. The minimum requirement by the U. S. P. is 1.12 Gms. of alkaloids in 100 mils against 1.8 Gms. of alkaloids in 100 mils of fluidextract, and 2.0 per cent in the crude drug.

Glyceritum Phenolis, *Glycerite of Carbolic Acid.* This preparation mixes with any proportion of water without separation of phenol. Liquefied phenol contains 10 per cent of water and not less than 87 per cent of phenol.

Glyceritum Bismuthi, N. F. Nitric acid converts bismuth subnitrate into the normal salt which is soluble in the excess of acid. A little heat may be necessary to effect solution. The addition of water is not sufficient to reprecipitate the subnitrate again. Tartaric acid is added and then sodium bicarbonate, which causes the precipitation of bismuth tartrate. This is washed free from sodium nitrate. To the precipitate are added tartaric acid and sodium bicarbonate in correct proportion to make the normal sodium tartrate which dissolves bismuth tartrate. This solution is slightly acid, but the addition of a mineral acid causes precipitation. The following equations approximately represent the reactions:

$$\underset{\substack{\text{Bismuth}\\ \text{subnitrate}}}{BiONO_3} + \underset{\substack{\text{Nitric}\\ \text{acid}}}{2HNO_3} = \underset{\substack{\text{Bismuth}\\ \text{nitrate}}}{Bi(NO_3)_3} + \underset{\text{Water}}{H_2O}.$$

$$\underset{\substack{\text{Bismuth}\\ \text{nitrate}}}{2Bi(NO_3)_3} + \underset{\text{Tartaric acid}}{3H_2C_4H_4O_6} + \underset{\substack{\text{Sodium}\\ \text{bicarbonate}}}{6NaHCO_3}$$

$$= \underset{\text{Bismuth tartrate}}{Bi_2(C_4H_4O_6)_3} + \underset{\substack{\text{Sodium}\\ \text{nitrate}}}{6NaNO_3} + \underset{\substack{\text{Carbon}\\ \text{dioxide}}}{6CO_2} + \underset{\text{Water}}{6H_2O}.$$

Glyceritum Guaiaci, N. F. Guaiac consists largely of resin acids which combine with potassium hydroxide to form soluble resin soaps.

Glyceritum Pepsini, N. F. Solutions of pepsin are difficult to filter clear. Paper pulp is rather better than talc in this case. While pepsin is quite permanent in the dry condition, it deteriorates slowly when in solution.

Glyceritum Picis Liquidæ, *Glycerite of Tar,* N. F. Washing with water largely removes acetic acid and phenol. Magnesium carbonate aids the removal of matter not soluble in the mixture of liquids.

Glyceritum Tragacanthæ, N. F. This is used as a pill excipient and as a base for ointments which may be washed off with water. Some time is required in making this glycerite, and it is preferably forced through a strainer several times.

Glyceritum Vitelli, *Glyconin,* N. F. Glycerite of yolk of egg is used chiefly in making emulsions. Glycerin preserves egg yolk for months and even years. Care should be taken to remove albumin and the enclosing membrane.

SYRUPS

Definition. A syrup is a solution of sugar in water, or water and alcohol, and is generally nearly saturated. Sugar in strong solution is a preservative, but in dilute solution it readily undergoes fermentation. One gram dissolves in about 0.5 mil of water or 170 mils of alcohol, but a very large proportion of alcohol must be added to a water solution before sugar is precipitated. In dissolving sugar in water the number of milliliters by which the volume of the liquid is increased is about the same as two-thirds of the number of grams of sugar dissolved. Seventy-five grams of sugar increase the volume about fifty milliliters. The best sugar obtainable should be used in making syrups. Poor grades are sometimes rendered white by adding a blue coloring substance, as ultramarine, which may separate when sugar is dissolved.

Methods of Making. Syrups are made: 1. By dissolving sugar with the aid of heat. 2. By dissolving sugar in the cold. 3. By percolation. 4. By adding medicinal agents to simple syrup. Heat hastens solution and coagulates pectinous and albuminous matter which may be in the liquid. The coagulum can be removed by straining, thereby lessening the tendency to fermentation. Heat is sometimes objectionable on account of injury to medicinal matter, or it sometimes causes inversion of sugar, particularly if an acid or a mineral salt is present, thus making the syrup more liable to ferment. A supersaturated solution should not be made with heat, as the excess of sugar will crystallize out on cooling, and the crystallization may go beyond the point of saturation, making for the time being a solution less than saturated. In making a syrup by percolation, a plug of sponge or absorbent cotton is put into the neck of a percolator, the sugar put in and water or solution of medicinal matter poured on. Some time is required for percolation, but the syrup is clear and brilliant. Quite a number of U. S. P. and N. F. syrups are made by adding a fluidextract to simple syrup. The syrup thus made is generally turbid until it has stood long enough for the precipitate to settle.

Preservation. In making syrups it is best to use recently distilled or at least boiled water. A new lot of syrup should not be mixed with an old one. The bottles or containers should be thoroughly cleaned and sterilized. Syrups should be kept in a cool place and protected from air. Bottles partly filled with hot syrup should be shaken after cooling so that the condensed water on the upper part of the bottle will not run down and dilute the upper part of the syrup and make it ferment. Glycerin or alcohol is sometimes used as a preservative, but a small amount may hasten fermentation. Glycerin has been added to several U. S. P. and N. F. syrups, it having a solvent as well as preservative effect. If a syrup has once fermented it will not keep long even though boiled, because all the spores of the ferment may not be destroyed, and the sugar has been diminished and partly inverted.

COMMENTS

Syrupus. Simple syrup contains 64.7 per cent of sugar. One pound measures about $11\frac{2}{3}$ ounces.

Syrupus Acaciæ. This syrup spoils very quickly, as do most liquids containing a mucilage. The container and stopper should be sterilized. The gum contains an enzyme which is entirely destroyed by the heat directed, and the syrup is not as likely to spoil.

Syrupus Acidi Citrici. This syrup is used when syrup of lemon is called for. Syrup of lemon was made by dissolving sugar in lemon juice; it did not keep well because of the albumin present. Syrup of citric acid may be opalescent at first on account of the oil precipitated. It sometimes acquires a turpentine-like taste, due to the oxidation of the oil. A fungous growth is apt to appear unless care is used in keeping it, and if present the syrup should not be used.

Syrupus Acidi Hydriodici. This syrup may become colored on standing, due to change of sugar by the acid or due to the liberation of iodine. In the latter case the addition of a little hypophosphorous acid changes the iodine back to hydriodic acid. Dilute hydriodic acid is made with hypophosphorous acid in it. If the color is due to caramelization, there is no satisfactory way of removing it when working with small quantities. Animal charcoal has been used, but it may take out some acid. The syrup contains about 1.2 per cent by weight of acid.

Syrupus Aurantii, *Syrup of Orange.* Talc is used to remove the fine precipitate which is formed when water is added to the tincture. Citric acid improves the taste.

Syrupus Calcii Lactophosphatis. This syrup probably contains calcium acid phosphate, calcium lactate, and lactic acid. The following equations indicate approximately the reactions:

$$\underset{\text{Calcium carbonate}}{CaCO_3} + \underset{\text{Lactic acid}}{2HC_3H_5O_3} = \underset{\text{Calcium lactate}}{Ca(C_3H_5O_3)_2} + \underset{\text{Carbon dioxide}}{CO_2} + \underset{\text{Water}}{H_2O}.$$

$$\underset{\text{Calcium lactate}}{Ca(C_3H_5O_3)_2} + \underset{\text{Phosphoric acid}}{2H_3PO_4} = \underset{\text{Calcium acid phosphate}}{Ca(H_2PO_4)_2} + \underset{\text{Lactic acid}}{2HC_3H_5O_3}.$$

The calcium acid phosphate in the nascent condition is more easily soluble in acid than when dry, or than the normal phosphate, consequently the U. S. P. starts with the calcium carbonate instead of the phosphate. When the phosphoric acid is added to the solution of calcium lactate a precipitate forms which does not always dissolve easily. If the phosphoric acid is diluted with twice the amount of water directed by the U. S. P. the precipitate will hardly be noticed. The formula in the U. S. P. VIII called for more sugar than could be readily dissolved, and yet the syrup spoiled more quickly than most syrups. In the present formula the sugar has been reduced and some glycerin added as a preservative.

Syrupus Ferri Iodidi. The chemical reaction may generate sufficient heat to volatilize some iodine, and if so it is necessary to apply cold. Near the end of the reaction the mixture is heated to boiling to complete the reaction, and the liquid should be entirely free from a reddish color. Excess of iron is used as it can be filtered out, whereas excess of iodine being in solution cannot be filtered out. Sugar is added to the solution before filtering and the filtrate is run directly into sugar, to protect ferrous iodide from oxidation. Hypophosphorous acid is added to prevent oxidation and liberation of iodine. The syrup may become red from change of sugar or liberation of iodine, and the remedy for the latter condition is hypophosphorous acid, which changes iodine to hydriodic acid. Direct sunlight with the syrup reduces iodine. The container should be well filled to keep out air.

$$\underset{\text{Iron}}{Fe} + \underset{\text{Iodine}}{2I} = \underset{\text{Ferrous iodide}}{FeI_2}.$$

Syrupus Hypophosphitum. Calcium hypophosphite often leaves an insoluble residue. Hypophosphorous acid dissolves this and improves the taste. It is better to dissolve as much of the salts as possible in water, allow to stand until the insoluble part settles, decant the clear solution, and add the acid to the residue. When the precipitate is dissolved the decanted part is mixed with it. In this way the acid is a better solvent, because it is more concentrated. Glycerin is added as a preservative.

Syrupus Ipecacuanhæ. Acetic acid is used supposedly to convert the alkaloids into soluble acetates. But hydrochloric acid is used in the fluidextract to make the alkaloids soluble in water and acetic acid does not displace it. In allowing the mixture to stand for twenty-four hours, the fine precipitate agglutinates and is more easily filtered out. Glycerin retards fermentation.

Syrupus Lactucarii. Water does not give much precipitate with tincture of lactucarium because in making the tincture the caoutchouc-like matter has been removed.

Syrupus Picis Liquidæ, *Syrup of Tar.* Magnesium carbonate helps to take out the fine precipitate which is formed when water is added to the alcoholic solution of tar.

Syrupus Pruni Virginianæ, *Syrup of Wild Cherry.* Glycerin is put into the menstruum as a preservative. It also acts as a solvent, makes the percolate darker, and dissolves out more tannin. In the maceration of the bark, a ferment converts amygdalin into glucose, benzaldehyde, and a small, variable amount of hydrocyanic acid. If heat were used to dissolve the sugar, the aldehyde and acid would be volatilized.

Syrupus Rhei. Potassium carbonate is used in this and in aromatic syrup of rhubarb to prevent precipitation of resin, forming a soluble compound with it.

Syrupus Sarsaparillæ Compositus. This mixture does not make a clear syrup, as the matter precipitated from the fluidextracts is not filtered out as formerly. On long standing the precipitated matter settles.

Syrupus Scillæ. A metallic vessel should be avoided in making this syrup on account of the acid in the vinegar. The syrups of squills, ipecac, sanguinaria, N. F., and garlic, N. F., contain acetic acid, and are sometimes used as expectorants with ammonium carbonate from which carbon dioxide is liberated. A little heat can be applied to hasten the liberation.

Syrupus Scillæ Compositus, *Hive Syrup.* This syrup should be made in small quantities, as it ferments quickly because of the albuminous matter in the fluidextracts. The precipitated matter from the fluidextracts is not filtered out as formerly.

Syrupus Senegæ. This syrup may be slightly alkaline with ammonia which was put into the fluidextract to prevent gelatinization. The syrup is clearer than might be expected because of the ammonia.

Syrupus Tolutanus. Magnesium carbonate is used in this syrup and in the syrup of ginger to aid the removal of finely precipitated matter caused by adding water to the alcoholic solutions.

Syrupus Althææ, N. F. While this syrup contains mucilaginous matter, it also contains 10 per cent by volume of glycerin, which acts as a preservative.

Syrupus Asari Compositus, N. F. Potassium carbonate aids the solution of resinous matter in asarum and the coloring matter in cochineal, and tends to prevent precipitation from fluidextract of ipecac, as well as having a slight therapeutic effect.

Syrupus Calcii Hydrochlorophosphatis, N. F. The hydrochloric acid converts calcium phosphate into the acid salt. Two acid phosphates are possible; the following reaction shows the formation of the more acid and more soluble one:

$$\underset{\substack{\text{Calcium}\\ \text{phosphate}}}{Ca_3(PO_4)_2} + \underset{\substack{\text{Hydrochloric}\\ \text{acid}}}{4HCl} = \underset{\substack{\text{Calcium acid}\\ \text{phosphate}}}{Ca(H_2PO_4)_2} + \underset{\substack{\text{Calcium}\\ \text{chloride}}}{2CaCl_2}.$$

Syrupus Calcii Iodii, N. F. When iodine, iron, and water are mixed, reaction commences slowly and increases. If much syrup is being made it is better not to warm the mixture as directed until near the end of the reaction, or iodine will be volatilized and lost. Warming will complete the reaction. This solution of ferrous iodide dissolves the balance of the iodine, and the warming is to aid solution. When the solution of iodine in ferrous iodide is poured into the boiling water with calcium carbonate, probably two reactions take place simultaneously, ferrous iodide being converted into ferric iodide, and the iron being precipitated by the carbonate as hydroxide. Ferric salts are more completely precipitated by calcium carbonate than ferrous. The finished syrup is practically colorless, and should contain no free iodine.

$$\underset{\text{Iodine}}{2I} + \underset{\text{Iron}}{Fe} = \underset{\substack{\text{Ferrous}\\ \text{iodide}}}{FeI_2}.$$

$$\underset{\substack{\text{Ferrous}\\ \text{iodide}}}{2FeI_2} + \underset{\text{Iodine}}{2I} + \underset{\substack{\text{Calcium}\\ \text{carbonate}}}{3CaCO_3} + \underset{\text{Water}}{3H_2O}$$

$$= \underset{\substack{\text{Calcium}\\ \text{iodide}}}{3CaI_2} + \underset{\substack{\text{Ferric}\\ \text{hydroxide}}}{2Fe(OH)_3} + \underset{\substack{\text{Carbon}\\ \text{dioxide}}}{3CO_2}.$$

Syrupus Calcii Lactophosphatis et Ferri, N. F. Ferrous lactate is not readily soluble in water, but is in a solution of potassium citrate. Nearly all insoluble iron salts can be brought into solution with the aid of alkali citrates.

Syrupus Codeinæ, N. F. It is better to heat only a small portion of syrup, dissolve the codeine in it, and add the balance of the syrup. One gram of codeine sulphate is soluble in 2 mils of water at 25° C., and is nearly as soluble in syrup.

Syrupus Eriodictyi Aromaticus, *Aromatic Syrup of Yerba Santa*, N. F. This syrup is used largely as a vehicle for quinine, and it should be highly aromatic. Potassium hydroxide keeps the resinous matter of the fluidextract in solution. Magnesium carbonate aids the removal of any precipitated matter or excess of oils.

Syrupus Ferri et Mangani Iodidi, N. F. The ferrous iodide formed by the action of iodine on iron is filtered into sugar to prevent the liberation of iodine by the air. Manganese iodide is made by mixing manganese sulphate in water with sodium iodide in dilute alcohol. Sodium sulphate which is soluble in water is insoluble in alcohol, and most of it is precipitated and filtered out. The manganous iodide is in the filtrate, and the finished syrup contains about 5 per cent by volume of alcohol.

$$\underset{\text{Iron}}{\mathrm{Fe}} + \underset{\text{Iodine}}{2\mathrm{I}} = \underset{\substack{\text{Ferrous}\\ \text{iodide}}}{\mathrm{FeI_2}}.$$

$$\underset{\substack{\text{Manganous}\\ \text{sulphate}}}{\mathrm{MnSO_4}} + \underset{\substack{\text{Sodium}\\ \text{iodide}}}{2\mathrm{NaI}} = \underset{\substack{\text{Manganous}\\ \text{iodide}}}{\mathrm{MnI_2}} + \underset{\substack{\text{Sodium}\\ \text{sulphate}}}{\mathrm{Na_2SO_4}}.$$

Syrupus Ferri Hypophosphitis, N. F. Ferric hypophosphite is nearly insoluble in water, but like many iron salts it dissolves in a solution of potassium citrate.

Syrupus Ferri Lactophosphatis, N. F. The phosphoric acid with ferrous lactate makes an acid phosphate which is soluble.

Syrupus Ferri, Quininæ et Strychninæ Phosphatum, N. F. This is sometimes known as Easton's syrup. Ferric phosphate, U. S. P., is a mixture or double compound of ferric phosphate and sodium citrate. It dissolves slowly in cold water. In using heat to dissolve it, it is better not to powder the scales because the powder sticks together, making a mass that does not dissolve quickly. Adding dilute acid to this solution causes the precipitation of ferric phosphate, but using the amount of phosphoric acid called for gives a ferric acid phosphate which is soluble. Quinine and strychnine combine with phosphoric acid to form soluble salts.

Syrupus Ferri Saccharati Solubilis, *Syrup of Soluble Oxide of Iron,* N. F. Saccharated ferric oxide is a mixture of ferric oxide and sugar. Ferric oxide is insoluble in water but soluble in the presence of sugar or syrup.

Syrupus Hypophosphitum Compositus, N. F. Sodium citrate aids the solution of hypophosphites of iron and manganese. Calcium hypophosphite often contains a little phosphate which is not soluble in water but dissolves when mixed with hypophosphorous acid. Quinine and strychnine alkaloids combine with hypophosphorous acid to make soluble hypophosphites.

Syrupus Iodotannicus, N. F. According to the U. S. Dispensatory (19th ed., p. 81), when iodine, tannic acid, and water are mixed, iodine combines with the hydrogen of the water, forming hydriodic acid which combines with tannic acid. The oxygen of the water decomposed combines with some more tannic acid to form an insoluble compound. This solution is capable of holding iodine in solution. Iodine in solution with tannic acid does not give the characteristic blue color with starch.

Syrupus Morphinæ et Acaciæ, N. F. Syrup of acacia itself spoils quickly, but the oil of sassafras here helps to preserve it.

Syrupus Papaveris, *Syrup of Poppy,* N. F. There seems to be no need of this syrup, since a formula containing morphine is given. Poppy capsules contain the alkaloids of opium, but the amount which water takes out varies considerably. As the value is due chiefly to morphine, it would be better to use a definite amount of alkaloid salt.

Syrupus Pini Strobi Compositus, *Compound Syrup of White Pine,* N. F. The menstruum used does not exhaust the resinous drugs. The formula, however, makes a good cough preparation.

Syrupus Quinidinæ, N. F. The alkaloid is nearly insoluble in water, consequently the syrup is called bitterless. The alkaloid is only suspended in the syrup, and settles on standing, hence the directions to shake well before dispensing. Quinidine is said to be less active therapeutically than quinine.

Syrupus Rosæ, N. F. Sulphuric acid is used to give it a more pleasant acidulous taste.

Syrupus Rubi Fructus, *Syrup of Blackberry,* N. F. The expressed liquid is heated to coagulate albuminous matter which is strained out. Sugar added to the juice before heating holds the flavor better than if added after heating. Directions are given to bottle the syrup under aseptic conditions.

Syrupus Rubi Idæi, *Syrup of Raspberry,* N. F. The juice contains a pectinous compound which is coagulated on standing. Mixing the clear juice with half its volume of alcohol and getting a clear liquid shows that pectin has been coagulated. Albuminous matter is removed by boiling and filtering.

Syrupus Sanguinariæ, N. F. Acetic acid renders the alkaloids soluble in water.

SOLUTIONS

Definition. Most of the preparations classed by the Pharmacopœia under this head are solutions of non-volatile substances in water. Exceptions to this definition are found in the antiseptic, compound chlorine, formaldehyde, and compound iodine solutions, because they contain volatile active ingredients, though they also contain some non-volatile matter. This is an important class, containing many preparations in which the ingredients are exceptionally active. There are twenty-five solutions recognized by the U. S. P., and fifty-two by the N. F.

COMMENTS

Liquor Acidi Arsenosi, *Solution of Arsenic Chloride.* On boiling arsenic trioxide, hydrochloric acid, and water together, arsenic trioxide combines with water to make arsenous acid.

$$\underset{\substack{\text{Arsenic}\\\text{trioxide}}}{As_2O_3} + \underset{\text{Water}}{3H_2O} = \underset{\substack{\text{Arsenous}\\\text{acid}}}{2H_3AsO_3}.$$

Hydrochloric acid is used to aid the solution of the trioxide which is soluble in from 30 to 100 parts of water. Water is added occasionally as the boiling must be continued for some time, the trioxide repelling water and floating on top. The name " solution of chloride of arsenic " is wrongly applied, as there is no chloride of arsenic present.

There are four U. S. P. solutions containing arsenic, all of them containing approximately 1 per cent. Solutions of arsenous acid, and of arsenic and mercuric iodide, are acid to litmus, while solutions of potassium arsenite and sodium arsenate are alkaline.

Liquor Ammonii Acetatis, *Spirit of Mindererus.* On dissolving ammonium carbonate in acetic acid, strong effervescence results.

$$\underset{\text{Ammonium carbonate}}{NH_4HCO_3 \cdot NH_4NH_2CO_2} + \underset{\text{Acetic acid}}{3HC_2H_3O_2} = \underset{\text{Ammonium acetate}}{3NH_4C_2H_3O_2} + \underset{\text{Carbon dioxide}}{2CO_2} + \underset{\text{Water}}{H_2O}.$$

Hard, translucent masses of ammonium carbonate should be used because they are more constant in composition than those which have some pulverulent powder. Official ammonium carbonate is a mixture of ammonium bicarbonate and ammonium carbonate, and on exposure loses ammonia and carbon dioxide, leaving ammonium bicarbonate. A given weight of ammonium bicarbonate requires less acetic acid for neutralization than the official salt. This solution has a better taste when it has carbon dioxide in it, consequently it should be made up as wanted. It should not be bottled before reaction is complete. On long keeping it may become alkaline.

Liquor Arseni et Hydrargyri Iodidi, *Donovan's Solution.* Mercuric iodide is insoluble in water, but dissolves in the solution of arsenous iodide, perhaps forming a double compound. This solution has a yellow color, but on exposure turns red and liberates iodine; to prevent this some pharmacists keep metallic mercury in the container. This practice may be objectionable because of the formation of too much mercuric iodide.

Liquor Calcis, *Lime Water.* In slaking lime too much water should not be added at first, only about one-half its weight, so as to produce heat and cause the lump to fall to a powder. The heat is due to chemical reaction.

$$\underset{\text{Lime}}{CaO}+\underset{\text{Water}}{H_2O}=\underset{\text{Calcium hydroxide}}{Ca(OH)_2}.$$

The supernatant liquid is rejected because it contains alkali salts, chlorides, and perhaps other soluble impurities. Lime made from marble is fairly pure and the best to be used. Excess of lime is left in the container in order to keep the water saturated, as calcium hydroxide in solution absorbs carbon dioxide from the air even on slight exposure, making the insoluble calcium carbonate. The conclusion must not be drawn that an unlimited amount of lime water can be made by the simple addition of water just because there is a white powder in the container; the precipitate may be calcium carbonate. Although this preparation is a very weak solution and is simple to make, the pharmacist should not neglect it. In dispensing, only the clear supernatant liquid should be used. If filtered, the funnel should be well covered, and the first part of the filtrate thrown away, as filter paper may remove some of the hydroxide from the solution. Calcium hydroxide is less soluble in hot water than cold, and heating a good solution renders it turbid.

Liquor Cresolis Compositus. Linseed oil with potassium hydroxide makes soft soap. The oil is a mixture of several oleins, the equation being given for linolein.

$$\underset{\text{Linolein}}{C_3H_5(C_{18}H_{31}O_2)_3} + \underset{\text{Potassium hydroxide}}{3KOH} = \underset{\text{Potassium linoleate}}{3KC_{18}H_{31}O_2} + \underset{\text{Glycerin}}{C_3H_5(OH)_3}.$$

Cresol, which is soluble in 60 parts of water, is readily soluble in this soap solution. On adding some of the finished solution to water a turbid mixture is made, due to the suspension of cresol. Sodium hydroxide in proper proportions may be used in place of the potassium hydroxide.

Liquor Ferri Chloridi. Two chemical reactions take place in making this solution:

$$\underset{\text{Iron}}{Fe} + \underset{\substack{\text{Hydrochloric}\\ \text{acid}}}{2HCl} = \underset{\substack{\text{Ferrous}\\ \text{chloride}}}{FeCl_2} + \underset{\text{Hydrogen}}{H_2}.$$

$$\underset{\substack{\text{Ferrous}\\ \text{chloride}}}{3FeCl_2} + \underset{\substack{\text{Hydro-}\\ \text{chloric}\\ \text{acid}}}{3HCl} + \underset{\substack{\text{Nitric}\\ \text{acid}}}{HNO_3} = \underset{\substack{\text{Ferric}\\ \text{chloride}}}{3FeCl_3} + \underset{\substack{\text{Nitric}\\ \text{oxide}}}{NO} + \underset{\text{Water}}{2H_2O}.$$

It is essential that the hydrochloric acid should be of the correct strength, as the amount of ferrous chloride depends on it. All of the acid is used up as there is an excess of iron to facilitate reaction. The mixture is heated to complete the first reaction given above. Nitric acid is used to convert the ferrous chloride into ferric chloride, and as the latter salt contains more chlorine than the former, it is necessary that more hydrochloric acid be added.

Pouring the ferrous chloride solution into the nitric acid may cause the production of a dark brown liquid on account of the compound formed of nitric oxide and ferrous chloride. The subsequent heat directed breaks up this dark compound and drives off slowly the nitric oxide and nitric acid. Sometimes difficulty is experienced in getting rid of all of the nitric acid because there is a deficient amount of hydrochloric acid, and some nitric acid is combined with iron. In such a case the careful addition of hydrochloric acid with heat will break up the nitrate. The heat required to drive off the nitric aid will also drive off much of the hydrochloric acid, so that a third portion must be added to make the finished product quite acid, otherwise basic chloride of iron will precipitate. This solution should be tested to see that it is free from ferrous salt, nitric acid, and basic ferric chloride.

Liquor Ferri et Ammonii Acetatis, *Basham's Mixture.* Part of the ferric chloride is changed to acetate which has a deeper red color than the chloride. The solution must be acid to prevent precipitation of basic ferric acetate. Glycerin also helps to prevent precipitation.

$$\underset{\substack{\text{Ferric}\\\text{chloride}}}{FeCl_3} + \underset{\substack{\text{Ammonium}\\\text{acetate}}}{3NH_4C_2H_3O_2} = \underset{\text{Ferric acetate}}{Fe(C_2H_3O_2)_3} + \underset{\substack{\text{Ammonium}\\\text{chloride}}}{3NH_4Cl}.$$

Liquor Ferri Subsulphatis, *Monsel's Solution.* This is a solution of a basic salt, there not being enough acid used to make the normal sulphate. Nitric acid oxidizes ferrous salt to ferric, and more sulphuric acid is needed for ferric sulphate than ferrous. To avoid the formation of a dangerous amount of effervescence, due to nitric oxide gas formed, the iron is added in four portions, and in working with large quantities the number of portions should be increased. The black color referred to is due to the same compound as is formed in making the ferrous sulphate test for nitric acid, and is said to be a compound of nitric oxide and ferrous salt. The production of red fumes shows the presence of some remaining ferrous salt. Monsel's solution is so nearly saturated that on chilling some of the compound is thrown out of solution, and for the same reason the addition of one-half volume of sulphuric acid causes a separation. Considerable difficulty is experienced in getting rid of the nitric acid, some of it being combined with iron because of a deficient amount of sulphuric acid to make the normal salt. The formula of ferric subsulphate varies, but the following equation approximately represents the reaction:

$$\underset{\substack{\text{Ferrous}\\\text{sulphate}}}{12FeSO_4} + \underset{\substack{\text{Sulphuric}\\\text{acid}}}{3H_2SO_4} + \underset{\substack{\text{Nitric}\\\text{acid}}}{4HNO_3} = \underset{\substack{\text{Ferric}\\\text{subsulphate}}}{3Fe_4O(SO_4)_5} + \underset{\substack{\text{Nitric}\\\text{oxide}}}{4NO} + \underset{\text{Water}}{5H_2O}.$$

Liquor Ferri Tersulphatis. The comments on the solution of ferric subsulphate apply to this solution, except that there is enough acid used to make the normal sulphate.

$$\underset{\text{Ferrous sulphate}}{6FeSO_4} + \underset{\text{Sulphuric acid}}{3H_2SO_4} + \underset{\text{Nitric acid}}{2HNO_3} = \underset{\text{Ferric sulphate}}{3Fe_2(SO_4)_3} + \underset{\text{Nitric oxide}}{2NO} + \underset{\text{Water}}{4H_2O}.$$

Liquor Formaldehydi, *Formalin.* Vapors of methyl alcohol are passed over heated copper gauze and the gas then passed into water. If the oxidation is carried too far, formic acid is produced. On heating or on keeping for some time this solution becomes weaker, due to volatilization of gas and to the separation of solid white paraformaldehyde, which is a condensation product. This solution becomes acid on account of oxidation of some formaldehyde to formic acid.

$$\underset{\text{Methyl alcohol}}{CH_4O} + \underset{\text{Oxygen}}{O} = \underset{\text{Formaldehyde}}{CH_2O} + \underset{\text{Water}}{H_2O}.$$

Liquor Hydrogenii Dioxidi, *Solution of Hydrogen Peroxide.* This preparation has been changed from the class waters to solutions, because hydrogen dioxide is only slightly volatile. It is frequently made from barium dioxide, the U. S. P. VII giving a formula. Hydrogen dioxide decomposes quite easily, and often a preservative is put in. Acetanilid ($\frac{3}{16}$ gr. to the ounce), is probably the best. Thirty-six commercial samples were examined by the writer, and they varied from 0 per cent to over the required 3 per cent of dioxide. Those samples to which acetanilid had been added invariably kept better than those not protected. Those containing acetanilid lose strength more rapidly as they get older, and sometimes develop an odor suggesting benzaldehyde. Ultimately the acetanilid may be entirely decomposed. Keeping bottles of hydrogen dioxide water tightly stoppered does not prevent the decomposition, and if kept for some time the bottles should be opened to avoid bursting. This water is always slightly acid; alkalies cause quite rapid decomposition into oxygen and water.

Liquor Iodi Compositus, *Lugol's Solution.* Iodine is nearly insoluble in water but readily soluble in a solution of potassium iodide.

Liquor Magnesii Citratis. Potassium bicarbonate, or sodium bicarbonate in proportionate amount, is put in at the last to carbonate the preparation, giving it a better taste. The carbon dioxide from magnesium carbonate cannot be well utilized for this, as the total amount is too large and it is hard to regulate. There should be enough acid so that the magnesium in the finished solution shall be partly in the form of an acid salt; the normal citrate is less soluble and may precipitate. The proportions directed make a mixture of a normal and acid salt. The containers should be placed on their sides to keep the stoppers wet, so that the gas will not escape. This solution may become turbid, due to growth of microörganisms which destroy the flavor. The bottles, stoppers, and water should be sterilized. To have this solution fresh when called for, some pharmacists make a concentrated solution of magnesium citrate, transferring to four-ounce bottles and sterilizing. When called for the contents of one of these bottles are mixed with the right amount of water, syrup, and bicarbonate.

$$\underset{\text{Magnesium carbonate}}{(MgCO_3)_4Mg(OH)_2}+\underset{\text{Citric acid}}{5H_3C_6H_5O_7}$$

$$=\underset{\substack{\text{Magnesium}\\\text{acid citrate}}}{5MgHC_6H_5O_7}+\underset{\substack{\text{Carbon}\\\text{dioxide}}}{4CO_2}+\underset{\text{Water}}{6H_2O}.$$

$$\underset{\substack{\text{Potassium}\\\text{bicarbonate}}}{2KHCO_3}+\underset{\text{Citric acid}}{H_3C_6H_5O_7}=\underset{\substack{\text{Potassium}\\\text{acid citrate}}}{K_2HC_6H_5O_7}+\underset{\substack{\text{Carbon}\\\text{dioxide}}}{2CO_2}+\underset{\text{Water}}{H_2O}.$$

Liquor Plumbi Subacetatis, *Goulard's Extract.* Boiling distilled water is used for dissolving lead acetate to get rid of oxygen, carbon dioxide, and other impurities that precipitate lead. Dilution of the solution is made with recently boiled distilled water for the same reason. It is necessary to add water occasionally while boiling to replace that which is evaporated. Practically the same products are formed in a few days without boiling, but heat hastens reaction. Filtration is always necessary, as there are insoluble basic compounds formed; the filter should be covered. This solution should be well protected from air, as it quickly absorbs carbon dioxide and gives considerable precipitate. The container will generally become coated with a white solid in a short time. It is sufficiently alkaline to cause precipitation when mixed with many other compounds. No formula can be given for the U. S. P. product, but the following equation approximately represents the reaction:

$$\underset{\text{Lead acetate}}{Pb(C_2H_3O_2)_2} + \underset{\substack{\text{Lead}\\\text{oxide}}}{PbO} = \underset{\text{Lead subacetate}}{Pb_2O(C_2H_3O_2)_2}.$$

Liquor Plumbi Subacetatis Dilutus, *Lead Water.* The water for dilution must be distilled, and recently boiled to free it from carbon dioxide so that it will not precipitate the lead.

Liquor Potassii Arsenitis, *Fowler's Solution.* The exact salt formed in this solution has not been definitely determined. Probably the first equation most nearly represents the reaction:

$$\underset{\substack{\text{Arsenic}\\\text{trioxide}}}{As_2O_3} + \underset{\substack{\text{Potassium}\\\text{bicarbonate}}}{4KHCO_3} = \underset{\substack{\text{Potassium}\\\text{acid arsenite}}}{2K_2HAsO_3} + \underset{\substack{\text{Carbon}\\\text{dioxide}}}{4CO_2} + \underset{\text{Water}}{H_2O}.$$

$$\underset{\substack{\text{Arsenic}\\\text{trioxide}}}{As_2O_3} + \underset{\substack{\text{Potassium}\\\text{bicarbonate}}}{2KHCO_3} + \underset{\text{Water}}{H_2O} = \underset{\substack{\text{Potassium}\\\text{acid arsenite}}}{2KH_2AsO_3} + \underset{\substack{\text{Carbon}\\\text{dioxide}}}{2CO_2}.$$

$$\underset{\substack{\text{Arsenic}\\ \text{trioxide}}}{As_2O_3} + \underset{\substack{\text{Potassium}\\ \text{bicarbonate}}}{2KHCO_3} = \underset{\substack{\text{Potassium}\\ \text{metarsenite}}}{2KAsO_3} + \underset{\substack{\text{Carbon}\\ \text{dioxide}}}{CO_2} + \underset{\text{Water}}{H_2O}.$$

$$\underset{\substack{\text{Potassium}\\ \text{bicarbonate}}}{2KHCO_3} + \text{Heat} = \underset{\substack{\text{Potassium}\\ \text{carbonate}}}{K_2CO_3} + \underset{\substack{\text{Carbon}\\ \text{dioxide}}}{CO_2} + \underset{\text{Water}}{H_2O}.$$

It is possible that the more acid salt is formed, and some claim that the metarsenite is formed. The last reaction always takes place, and it is the carbonate formed that makes the solution alkaline. This alkalinity causes many incompatibilities, and in many prescriptions should be neutralized. The bicarbonate is used in place of the carbonate because it is purer. The tincture gives color and taste. It is advised that Fowler's solution should not be kept longer than a year, as it is slowly oxidized to the arsenic condition which is less active therapeutically.

Liquor Potassii Citratis. This solution should be made up fresh when wanted, as the carbon dioxide in it makes it pleasanter to take, and a fungous growth is likely to form on standing. Lemon juice was formerly used in place of citric acid, and this was known as "neutral mixture." A slight excess of acid is used to give an acidulous taste.

$$\underset{\substack{\text{Potassium}\\ \text{bicarbonate}}}{3KHCO_3} + \underset{\text{Citric acid}}{H_3C_6H_5O_7} = \underset{\substack{\text{Potassium}\\ \text{citrate}}}{K_3C_6H_5O_7} + \underset{\substack{\text{Carbon}\\ \text{dioxide}}}{3CO_2} + \underset{\text{Water}}{3H_2O}.$$

Liquor Potassii Hydroxidi, *Solution of Potassa.* The solid potassium hydroxide, U. S. P., may contain as much as 15 per cent impurities, and for this reason, 60 Gms. are directed instead of 50 Gms. in making 1000 mils. This makes about a 5 per cent solution. The impurities most commonly present are silica, carbon dioxide, and water. A green glass bottle is better than flint glass because it is not so easily attacked by the alkali. If a glass-stoppered bottle is used as a container, the stopper should be coated with petrolatum to prevent its being cemented in. Only a small amount of solution should be made at a time.

Liquor Sodæ Chlorinatæ, *Labarraque's Solution.* Chlorinated lime is a mixture of calcium hypochlorite, calcium chloride, with perhaps some calcium carbonate and hydroxide. Calcium chloride is what makes it hygroscopic. There is a difference of opinion as to the composition of chlorinated lime, but the reaction can be indicated by the equation:

$$\underset{\substack{\text{Calcium}\\ \text{hypochlorite}}}{\mathrm{Ca(OCl)_2}} + \underset{\substack{\text{Calcium}\\ \text{chloride}}}{\mathrm{CaCl_2}} + \underset{\substack{\text{Sodium}\\ \text{carbonate}}}{\mathrm{2Na_2CO_3}} = \underset{\substack{\text{Sodium}\\ \text{hypochlorite}}}{\mathrm{2NaOCl}} + \underset{\substack{\text{Sodium}\\ \text{chloride}}}{\mathrm{2NaCl}} + \underset{\substack{\text{Calcium}\\ \text{carbonate}}}{\mathrm{2CaCO_3}}.$$

By "available chlorine" is meant the chlorine which is produced by the addition of an acid, and it comes from the hypochlorite and not from the chloride. By adding the sodium carbonate solution hot, the calcium carbonate precipitated is denser and more easily filtered. This solution should be kept in glass-stoppered bottles away from light, as carbon dioxide and light liberate chlorine and weaken the solution, and chlorine attacks cork.

Liquor Sodii Arsenatis. This solution contains 1 per cent of dried sodium arsenate, and is frequently alkaline. It is not often used. The anhydrous salt is more uniform than the crystallized as the amount of water of crystallization varies. Each of the four contain about 1 per cent of the arsenic compound.

Liquor Sodii Chloridi Physiologicus, *Normal Salt Solution.* This solution is used largely for dissolving agents to be injected hypodermically and for intravenous injections, and it should be thoroughly sterilized. This solution does not cause as much irritation and does not crenate the red blood corpuscles as much as pure water.

Liquor Sodii Hydroxidi, *Solution of Soda.* Solid sodium hydroxide may contain as much as 10 per cent impurities. To make about a 5 per cent solution, 5.6 Gms. are directed for 100 Gms. of solution. The comments on the solution of potassium hydroxide apply here.

Liquor Zinci Chloridi. Zinc often contains iron, and directions are given for removing this. It is dissolved with the zinc, forming ferrous chloride, which is converted into a ferric salt by nitric acid and precipitated by zinc carbonate as ferric hydroxide. The supernatant liquid is decanted because if passed through a filter it would dissolve the paper. By using zinc carbonate as the precipitant the introduction of impurities is avoided. During the process, the salt is fused to drive off the nitric acid, and in fusing care must be taken not to use too high a temperature or the zinc chloride is partly decomposed with loss of chlorine, leaving an insoluble zinc compound.

$$\underset{\text{Zinc}}{\mathrm{Zn}} + \underset{\text{Hydrochloric acid}}{\mathrm{2HCl}} = \underset{\text{Zinc chloride}}{\mathrm{ZnCl_2}} + \underset{\text{Hydrogen}}{\mathrm{2H}}.$$

$$\underset{\text{Iron}}{\mathrm{Fe}} + \underset{\text{Hydrochloric acid}}{\mathrm{2HCl}} = \underset{\text{Ferrous chloride}}{\mathrm{FeCl_2}} + \underset{\text{Hydrogen}}{\mathrm{2H}}.$$

$$\underset{\text{Ferrous chloride}}{\mathrm{3FeCl_2}} + \underset{\text{Hydrochloric acid}}{\mathrm{3HCl}} + \underset{\text{Nitric acid}}{\mathrm{HNO_3}} = \underset{\text{Ferric chloride}}{\mathrm{3FeCl_3}} + \underset{\text{Nitric oxide}}{\mathrm{NO}} + \underset{\text{Water}}{\mathrm{2H_2O}}.$$

$$\underset{\text{Ferric chloride}}{\mathrm{2FeCl_3}} + \underset{\text{Zinc carbonate}}{\mathrm{3ZnCO_3}} + \underset{\text{Water}}{\mathrm{3H_2O}} = \underset{\text{Ferric hydroxide}}{\mathrm{2Fe(OH)_3}} + \underset{\text{Zinc chloride}}{\mathrm{3ZnCl_2}} + \underset{\text{Carbon dioxide}}{\mathrm{3CO_2}}.$$

Liquor Alumini Acetatis, *Burow's Solution,* N. F. In the chemical reaction which takes place, lead sulphate is precipitated as a fine powder, so fine that it passes through ordinary filter paper. A paper which holds the precipitate causes the filtration to be very slow, consequently the clear liquid is decanted. In straining the magma, more or less of the precipitate goes through, but the directions are to use only the clear solution.

$$\underset{\text{Lead acetate}}{\mathrm{3Pb(C_2H_3O_2)_2}}+\underset{\substack{\text{Aluminum}\\\text{sulphate}}}{\mathrm{Al_2(SO_4)_3}}=\underset{\substack{\text{Aluminum}\\\text{acetate}}}{\mathrm{2Al(C_2H_3O_2)_3}}+\underset{\substack{\text{Lead}\\\text{sulphate}}}{\mathrm{3PbSO_4}}.$$

Liquor Alumini Acetico-Tartratis, N. F. The aluminum hydroxide first formed is gelatinous, and holds a considerable amount of water. The washing is slow. Letting it drain until it shrinks is to get rid of the water so that there will not be so much to evaporate, after dissolving in the acids. Theoretically there is a little more aluminum than is necessary to combine with the acids to form normal salts. The reactions may be represented by the following equations:

$$\underset{\substack{\text{Ammonium}\\\text{alum}}}{\mathrm{2NH_4Al(SO_4)_2}}+\underset{\substack{\text{Sodium}\\\text{carbonate}}}{\mathrm{3Na_2CO_3}}+\underset{\text{Water}}{\mathrm{3H_2O}}$$

$$=\underset{\substack{\text{Aluminum}\\\text{hydroxide}}}{\mathrm{2Al(OH)_3}}+\underset{\substack{\text{Sodium}\\\text{sulphate}}}{\mathrm{3Na_2SO_4}}+\underset{\substack{\text{Ammonium}\\\text{sulphate}}}{\mathrm{(NH_4)_2SO_4}}+\underset{\substack{\text{Carbon}\\\text{dioxide}}}{\mathrm{3CO_2}}.$$

$$\underset{\substack{\text{Aluminum}\\\text{hydroxide}}}{\mathrm{2Al(OH)_3}}+\underset{\substack{\text{Tartaric}\\\text{acid}}}{\mathrm{3H_2C_4H_4O_6}}=\underset{\substack{\text{Aluminum}\\\text{tartrate}}}{\mathrm{Al_2(C_4H_4O_6)_3}}+\underset{\text{Water}}{\mathrm{6H_2O}}.$$

$$\underset{\substack{\text{Aluminum}\\\text{hydroxide}}}{\mathrm{Al(OH)_3}}+\underset{\text{Acetic acid}}{\mathrm{3HC_2H_3O_2}}=\underset{\substack{\text{Aluminum}\\\text{acetate}}}{\mathrm{Al(C_2H_3O_2)_3}}+\underset{\text{Water}}{\mathrm{3H_2O}}.$$

Liquor Alumini Subacetatis, N. F. Like other basic salts, aluminum subacetate exists in several forms, some of which are insoluble in water. The one represented by the formula given in the N. F. is soluble.

$$\underset{\substack{\text{Aluminum}\\\text{sulphate}}}{\mathrm{Al_2(SO_4)_3}}+\underset{\substack{\text{Calcium}\\\text{carbonate}}}{\mathrm{3CaCO_3}}+\underset{\text{Water}}{\mathrm{3H_2O}}=\underset{\substack{\text{Aluminum}\\\text{hydroxide}}}{\mathrm{2Al(OH)_3}}+\underset{\substack{\text{Calcium}\\\text{sulphate}}}{\mathrm{3CaSO_4}}+\underset{\substack{\text{Carbon}\\\text{dioxide}}}{\mathrm{CO_2}}.$$

$$\underset{\substack{\text{Aluminum}\\\text{hydroxide}}}{\mathrm{Al(OH)_3}}+\underset{\text{Acetic acid}}{\mathrm{2HC_2H_3O_2}}=\underset{\substack{\text{Aluminum}\\\text{subacetate}}}{\mathrm{Al(C_2H_3O_2)_2OH}}+\underset{\text{Water}}{\mathrm{2H_2O}}.$$

Liquor Ammonii Citratis, N. F. The use of litmus paper as indicator shows when the normal citrate is formed. Ammonium citrate in water is a solvent for lead compounds, consequently the N. F. directs the use of "bottles free from lead." Solutions of citrates often develop fungous growths, hence precautions should be taken to prevent these as far as possible.

$$\underset{\text{Citric acid}}{H_3C_6H_5O_7} + \underset{\substack{\text{Ammonium}\\ \text{hydroxide}}}{3NH_4OH} = \underset{\substack{\text{Ammonium}\\ \text{citrate}}}{(NH_4)_3C_6H_5O_7} + \underset{\text{Water}}{3H_2O}.$$

Liquor Antisepticus, N. F. The formula now calls for sodium salicylate and sodium benzoate instead of the free acids. The salts are less irritating, and, as antiseptics, are less effective. The alcohol in the solution causes some irritation when applied to a broken surface.

Liquor Antisepticus Alkalinus, N. F. The effervescence noted is due to a reaction between borax, glycerin, and water, forming boric acid, which liberates carbon dioxide from potassium bicarbonate. For a full explanation, see under Liquor Sodii Boratis Compositus. This solution is not as irritating as the antiseptic solution because it does not have much alcohol in it, and it is slightly alkaline.

Liquor Arsenicalis, Clemens, *Solution of Potassium Arsenate and Bromide,* N. F. The reactions which take place probably vary with conditions, but may be represented by the following equations:

$$\underset{\substack{\text{Potassium}\\ \text{bicarbonate}}}{2KHCO_3} = \underset{\substack{\text{Potassium}\\ \text{carbonate}}}{K_2CO_3} + \underset{\text{Water}}{H_2O} + \underset{\substack{\text{Carbon}\\ \text{dioxide}}}{CO_2}.$$

$$\underset{\substack{\text{Arsenic}\\ \text{trioxide}}}{As_2O_3} + \underset{\substack{\text{Potassium}\\ \text{carbonate}}}{2K_2CO_3} + \underset{\text{Water}}{H_2O} = \underset{\substack{\text{Potassium}\\ \text{acid arsenite}}}{2K_2HAsO_3} + \underset{\substack{\text{Carbon}\\ \text{dioxide}}}{2CO_2}.$$

$$\underset{\substack{\text{Potassium}\\ \text{carbonate}}}{K_2CO_3} + \underset{\substack{\text{Potassium}\\ \text{acid arsenite}}}{K_2HAsO_3} + \underset{\text{Bromine}}{2Br} = \underset{\substack{\text{Potassium}\\ \text{acid arsenate}}}{K_2HAsO_4} + \underset{\substack{\text{Potassium}\\ \text{bromide}}}{2KBr} + \underset{\substack{\text{Carbon}\\ \text{dioxide}}}{CO_2}.$$

Liquor Auri et Arseni Bromidi, N. F. Heating bromine with arsenous oxide converts this into arsenic acid. There is no combination between arsenic acid and bromine or hydrobromic acid, and the title of arsenic bromide is incorrect. All free bromine is removed.

$$\underset{\substack{\text{Arsenic}\\\text{trioxide}}}{As_2O_3} + \underset{\text{Bromine}}{4Br} + \underset{\text{Water}}{5H_2O} = \underset{\substack{\text{Arsenic}\\\text{acid}}}{2H_3AsO_4} + \underset{\substack{\text{Hydrobromic}\\\text{acid}}}{4HBr}$$

Liquor Bromi, N. F. While bromine is soluble in about 30 parts of water, the presence of potassium bromide makes it much more soluble. Bromine in water solution, particularly in the light, changes quickly, forming hydrobromic acid.

Liquor Calcis Sulphuratæ, *Vleminckx' Lotion*, N. F. Solution of sulphurated lime has an orange-red color. There are several different compounds likely to be formed, depending upon the proportions of lime and sulphur and the amount of heating. From the proportions given there are probably formed some disulphides and pentasulphides of lime.

$$\underset{\text{Lime}}{3CaO} + \underset{\text{Sulphur}}{6S} = \underset{\substack{\text{Calcium}\\\text{disulphide}}}{2CaS_2} + \underset{\substack{\text{Calcium}\\\text{thiosulphate}}}{CaS_2O_3}.$$

$$\underset{\text{Lime}}{3CaO} + \underset{\text{Sulphur}}{12S} = \underset{\substack{\text{Calcium}\\\text{pentasulphide}}}{2CaS_5} + \underset{\substack{\text{Calcium}\\\text{thiosulphate}}}{CaS_2O_3}.$$

A similar reaction takes place in making a solution from which precipitated sulphur is obtained, and also in making the lime-sulphur solution used in spraying trees. The value of the solution depends upon the sulphides rather than the thiosulphate.

Liquor Carmini, N. F. Carmine is an aluminum " lake " containing the coloring principle from cochineal. It is only sparingly soluble in water, but dissolves readily in ammonia water, giving a purplish red solution. The excess of ammonia is driven off by heat. This solution is used only as a coloring agent, and should not be used to color acid liquids as acids precipitate carmine.

Liquor Chlori Compositus, *Chlorine Water*, N. F. From the proportion of hydrochloric acid and potassium chlorate directed, there are probably two chemical reactions which take place:

$$\underset{\text{Potassium chlorate}}{KClO_3} + \underset{\text{Hydrochloric acid}}{6HCl} = \underset{\text{Potassium chloride}}{KCl} + \underset{\text{Chlorine}}{3Cl_2} + \underset{\text{Water}}{4H_2O}.$$

$$\underset{\text{Potassium chlorate}}{2KClO_3} + \underset{\text{Hydrochloric acid}}{4HCl} = \underset{\text{Chlorine}}{2Cl} + \underset{\text{Potassium chloride}}{2KCl} + \underset{\text{Chlorine peroxide}}{2ClO_2} + \underset{\text{Water}}{2H_2O}.$$

Chlorine water is much more easily made by this formula than that of the U. S. P. VII but is not as pure; it now contains oxides of chlorine, which give a yellowish green color, and potassium chloride. The mixture of chlorate and acid is warmed to increase the reaction, and the tube is to allow the escape of air. The solution becomes weaker on keeping, due partly to volatilization of chlorine and partly to the formation of hydrochloric acid. On account of this rapid change, only the freshly made solution should be used, and it should be dispensed in well-filled amber bottles. This solution is a little weaker than formerly.

Liquor Cocci, *Cochineal Solution*, N. F. This is quite similar to solution of carmine. Potassium carbonate aids solution of the coloring matter. It also precipitates aluminum hydroxide, which forms a "lake" with the coloring matter. With potassium bitartrate the lake makes a soluble compound.

Liquor Ferri Acetatis, N. F. This solution has a deep red color. To prevent the formation of a basic salt, the solutions of iron and ammonia are kept cold, and the iron is poured into the ammonia, which keeps ammonia in excess at all times. The magma is washed by decantation, as it is bulky and takes a long time to wash, and if put on a filter some of it would get dry, forming some oxide instead of hydroxide. The ferric hydroxide is dissolved in acetic acid without heat, as heat would be likely to precipitate some basic acetate.

$$\underset{\substack{\text{Ferric}\\\text{sulphate}}}{Fe_2(SO_4)_3}+\underset{\substack{\text{Ammonium}\\\text{hydroxide}}}{6NH_4OH}=\underset{\substack{\text{Ferric}\\\text{hydroxide}}}{2Fe(OH)_3}+\underset{\substack{\text{Ammonium}\\\text{sulphate}}}{3(NH_4)_2SO_4}.$$

$$\underset{\substack{\text{Ferric}\\\text{hydroxide}}}{Fe(OH)_3}+\underset{\text{Acetic acid}}{3HC_2H_3O_2}=\underset{\text{Ferric acetate}}{Fe(C_2H_3O_2)_3}+\underset{\text{Water}}{3H_2O}.$$

Liquor Ferri Albuminati, N. F. The oxychloride of iron combines with and coagulates the egg albumin, but like many other insoluble iron compounds, it is soluble in a solution of an alkali citrate.

Liquor Ferri Citratis, N. F. The same precautions are necessary in making ferric hydroxide as those which are explained under Solution of Ferric Acetate. Heat of not over 60° C. is directed as a higher heat in the presence of an organic acid tends to reduce the ferric to ferrous compound.

$$\underset{\substack{\text{Ferric}\\\text{sulphate}}}{Fe_2(SO_4)_3}+\underset{\substack{\text{Ammonium}\\\text{hydroxide}}}{6NH_4OH}=\underset{\substack{\text{Ferric}\\\text{hydroxide}}}{2Fe(OH)_3}+\underset{\substack{\text{Ammonium}\\\text{sulphate}}}{3(NH_4)_2SO_4}.$$

$$\underset{\substack{\text{Ferric}\\\text{hydroxide}}}{Fe(OH)_3}+\underset{\text{Citric acid}}{H_3C_6H_5O_7}=\underset{\text{Ferric citrate}}{FeC_6H_5O_7}+\underset{\text{Water}}{3H_2O}.$$

Liquor Ferri Hypophosphitis, N. F. Ferric hypophosphite is practically insoluble in water, but is soluble in a solution of a citrate, probably forming a double compound.

Liquor Ferri Nitratis, N. F. For comments on the formation of ferric hydroxide, see under Solution of Ferric Acetate.

$$\underset{\text{Ferric sulphate}}{Fe_2(SO_4)_3} + \underset{\text{Ammonium hydroxide}}{6NH_4OH} = \underset{\text{Ferric hydroxide}}{2Fe(OH)_3} + \underset{\text{Ammonium sulphate}}{3(NH_4)_2SO_4}.$$

$$\underset{\text{Ferric hydroxide}}{Fe(OH)_3} + \underset{\text{Nitric acid}}{3HNO_3} = \underset{\text{Ferric nitrate}}{Fe(NO_3)_3} + \underset{\text{Water}}{3H_2O}.$$

Liquor Ferri Oxychloridi, N. F. For comments on the production of ferric hydroxide, see under Solution of Ferric Acetate. In dissolving the ferric hydroxide in hydrochloric acid there is not enough acid to make the normal salt. The compounds formed vary so that no formula can be given. Glycerin helps to prevent precipitation.

Liquor Ferri Oxysulphatis, N. F. Nitric acid oxidizes ferrous sulphate to ferric. Normal ferric sulphate requires more sulphuric acid than ferrous, but none is added. When iron is first oxidized some exists as ferric nitrate, but on boiling, a part of the nitric acid is driven off, leaving a basic salt. No directions are given for the complete removal of nitric acid, and in most cases a varying amount will remain. This solution is about one-fourth as strong as the U. S. P. subsulphate solution.

Liquor Ferri Peptonati, N. F. In the first part of the process, albumin is digested by pepsin, making acid albuminates, proteoses, peptones, and other products. The amounts of these probably vary with each solution made. In the previous edition peptone was directed to be used, but commercial peptones vary in their composition. They also sometimes have a disagreeable odor which egg albumin does not. Sodium citrate aids the solution of iron peptonate.

Liquor Ferri Protochloridi, *Solution of Ferrous Chloride,* N. F. Ferrous chloride is made in the same way as it is in making ferric chloride. Hypophosphorous acid is added to keep the iron in the ferrous condition. Solutions of ferrous salts are generally green.

$$\underset{\text{Iron}}{Fe} + \underset{\substack{\text{Hydrochloric}\\ \text{acid}}}{2HCl} = \underset{\substack{\text{Ferrous}\\ \text{chloride}}}{FeCl} + \underset{\text{Hydrogen}}{2H}$$

Liquor Ferri Salicylatis, N. F. Ammonium carbonate with citric acid forms ammonium citrate. There is also some sodium citrate in the tincture of citro-chloride of iron. The alkali citrates keep ferric salicylate in solution, and afford a deep red solution instead of the violet given by pure ferric salicylate. If it were not for the citrates, sodium salicylate would give ferric salicylate as a sticky mass which could not be suspended.

$$\begin{aligned}&\underset{\text{Ammonium carbonate}}{NH_4HCO_3 \cdot NH_4NH_2CO_2} + \underset{\text{Citric acid}}{H_3C_6H_5O_7}\\ &\qquad = \underset{\text{Ammonium citrate}}{(NH_4)_3C_6H_5O_7} + \underset{\substack{\text{Carbon}\\ \text{dioxide}}}{2CO_2} + \underset{\text{Water}}{H_2O}.\end{aligned}$$

No equation can be given showing the reaction between the iron and salicylate because the tincture citro-chloride of iron contains a double salt or varying proportions of ferric citrate and ferric chloride. The citrate also probably has some effect on the formation of ferric salicylate.

Liquor Guttæ Perchæ, N. F. Gutta percha does not give a clear solution with chloroform. Lead carbonate is a heavy insoluble powder, and in settling clears the liquid, carrying insoluble matter with it.

Liquor Hydrargyri et Potassii Iodidi, *Channing's Solution,* N. F. Mercuric iodide is insoluble in water, but combines with potassium iodide, forming a soluble compound. A weak solution of this double compound is known as "Mayer's reagent," and is used to detect alkaloids.

$$\underset{\substack{\text{Mercuric}\\\text{iodide}}}{\mathrm{HgI_2}} + \underset{\substack{\text{Potassium}\\\text{iodide}}}{\mathrm{2KI}} = \underset{\substack{\text{Potassium}\\\text{mercuric iodide}}}{\mathrm{(KI)_2HgI_2}}.$$

Liquor Hydrargyri Nitratis, N. F. This solution can be made from metallic mercury, but it is easier to make it from the oxide. It is rarely used.

$$\underset{\substack{\text{Mercuric}\\\text{oxide}}}{\mathrm{HgO}} + \underset{\substack{\text{Nitric}\\\text{acid}}}{\mathrm{2HNO_3}} = \underset{\substack{\text{Mercuric}\\\text{nitrate}}}{\mathrm{Hg(NO_3)_2}} + \underset{\text{Water}}{\mathrm{H_2O}}.$$

Liquor Hypophosphitum Compositus, N. F. The ingredients are practically the same as in the Compound Syrup of Hypophosphites, and the comments given there apply to this preparation.

Liquor Iodi Phenolatus, *Carbolized Solution of Iodine, Boulton's Solution,* N. F. In the cold and dark there seems to be but little reaction between the constituents of this solution. In the presence of alkalies iodo-phenols are formed, and probably sunlight produces similar compounds.

Liquor Pancreatini, N. F. Pancreatin acts best in an alkaline solution, and sodium bicarbonate is used for that reason. Sodium chloride in small amount aids the solution of many forms of albuminous substances, but added to saturation it may precipitate some.

Liquor Pepsini, N. F. Pepsin is destroyed by alkalies, and acts better in acid than in neutral solutions. Hydrochloric acid is added in making the solution, and the glycerite also contains some.

Liquor Pepsini Antisepticus, N. F. This is not intended for internal administration, but only as an external application to wounds. The action of pepsin is probably inhibited to some extent by the antiseptics, menthol and eucalyptol.

Liquor Phosphatum Acidus, N. F. Phosphoric acid forms two series of acid salts. In this formula enough acid is used to form the more acid salts which are soluble.

$$\underset{\text{Magnesium carbonate}}{(MgCO_3)_4\cdot Mg(OH)_2}+\underset{\text{Phosphoric acid}}{10H_3PO_4}$$

$$=\underset{\text{Magnesium acid phosphate}}{5Mg(H_2PO_4)_2}+\underset{\text{Carbon dioxide}}{4CO_2}+\underset{\text{Water}}{6H_2O}.$$

$$\underset{\text{Calcium carbonate}}{CaCO_3}+\underset{\text{Phosphoric acid}}{2H_3PO_4}=\underset{\text{Calcium acid phosphate}}{Ca(H_2PO_4)_2}+\underset{\text{Carbon dioxide}}{CO_2}+\underset{\text{Water}}{H_2O}.$$

Liquor Phosphatum Compositus, N. F. There is more than enough citric acid to convert the calcium carbonate and the bicarbonates of potassium and sodium into normal citrates. When phosphoric acid is added the citrates are partly converted into acid phosphates. Ferric phosphate is not precipitated because of the presence of citrates or the large amount of acid.

Liquor Phosphori, N. F. Dehydrated alcohol is directed because it is a better solvent for phosphorus than the ordinary alcohol, and even in the dehydrated it dissolves slowly.

Liquor Picis Alkalinus, *Alkaline Solution of Tar,* N. F. Potassium hydroxide combines with the acid constituents of tar, and dissolves resinous matter, and some other constituents which are not soluble in water.

Liquor Picis Carbonis, *Coal Tar Solution,* N. F. Alcohol dissolves some constituents of coal tar which are not soluble in water. When water is mixed with this solution these constituents are more or less precipitated. The quillaija is used to keep them suspended.

Liquor Potassæ Chlorinatæ, *Javelle Water,* N. F. The reactions are similar to those which take place in making solution of chlorinated soda; the strength is about four-fifths that of the soda solution.

Liquor Sodii Arsenatis, Pearson, N. F. This solution is one-tenth as strong as the U. S. P. solution of this salt. The N. F. III used the crystallized salt, and necessarily a larger amount, but the present formula agrees with the U. S. P. in using the anhydrous salt.

Liquor Sodii Boratis Compositus, *Dobell's Solution,* N. F. Effervescence results as carbon dioxide is liberated from the bicarbonate. Phenol, commonly known as carbolic acid, while slightly acid, does not liberate carbon dioxide, but it is boric acid which does. Borax is decomposed by glycerin, and according to some writers, sodium metaborate and boroglycerin are formed and the boroglycerin is decomposed by water into boric acid and glycerin. Other writers say that borax and glycerin mixed in proportion of one molecule of the former to two of the latter form sodium glyceroborate and boric acid, but when mixed in the proportion of one molecule of borax to four molecules of glycerin (which is approximately the case in this solution), sodium glyceroborate and glyceroboric acid are formed. Glyceroboric acid is a stronger acid than boric. Carbon dioxide is liberated by one or the other of these acids, and must be allowed to escape before bottling the preparation.

$$\underset{\text{Borax}}{Na_2B_4O_7} + \underset{\text{Glycerin}}{2C_3H_5(OH)_3} = \underset{\text{Boroglycerin}}{2C_3H_5BO_3} + \underset{\substack{\text{Sodium}\\\text{metaborate}}}{2NaBO_2} + \underset{\text{Water}}{3H_2O}.$$

$$\underset{\text{Boroglycerin}}{C_3H_5BO_3} + \underset{\text{Water}}{3H_2O} = \underset{\text{Glycerin}}{C_3H_5(OH)_3} + \underset{\text{Boric acid}}{H_3BO_3}.$$

Or,

$$\underset{\text{Borax}}{Na_2B_4O_7} + \underset{\text{Glycerin}}{2C_3H_5(OH)_3} + \underset{\text{Water}}{H_2O}$$

$$= \underset{\substack{\text{Sodium}\\\text{glyceroborate}}}{2NaC_3H_5OHBO_3} + \underset{\text{Boric acid}}{2H_3BO_3}.$$

$$\underset{\text{Borax}}{Na_2B_4O_7}+\underset{\text{Glycerin}}{4C_3H_5(OH)_3}$$

$$=\underset{\text{Sodium glyceroborate}}{2NaC_3H_5OHBO_3}+\underset{\text{Glyceroboric acid}}{2HC_3H_5OHBO_3}+\underset{\text{Water}}{3H_2O}.$$

$$\underset{\substack{\text{Glyceroboric}\\ \text{acid}}}{HC_3H_5OHBO_3}+\underset{\substack{\text{Sodium}\\ \text{bicarbonate}}}{NaHCO_3}=\underset{\substack{\text{Sodium}\\ \text{glyceroborate}}}{NaC_3H_5OHBO_3}+\underset{\substack{\text{Carbon}\\ \text{dioxide}}}{CO_2}+\underset{\text{Water}}{H_2O}.$$

Liquor Sodii Citratis, N. F. The proportions directed form practically the normal citrate, yielding about a 2.5 per cent solution. It is somewhat similar to the U. S. P. solution of potassium citrate, but weaker. By stoppering the bottle immediately, a little carbon dixoide is retained and adds to the taste.

$$\underset{\substack{\text{Sodium}\\ \text{bicarbonate}}}{3NaHCO_3}+\underset{\text{Citric acid}}{H_3C_6H_5O_7}=\underset{\text{Sodium citrate}}{Na_3C_6H_5O_7}+\underset{\text{Water}}{3H_2O}+\underset{\substack{\text{Carbon}\\ \text{dioxide}}}{3CO_2}.$$

Liquor Sodii Citro-Tartratis Effervescens, N. F. When a part of the sodium bicarbonate is mixed with the acids, the carbon dioxide formed is allowed to escape, and there is still an excess of acids. When the balance of the sodium bicarbonate is added and the bottle stoppered, the carbon dioxide is retained under pressure and makes the preparation more palatable. To retain the carbon dioxide from all of the bicarbonate would give too much.

Liquor Sodii Phosphatis Compositus, N. F. Chemical reaction takes place between citric acid and sodium phosphate, liberating water of crystallization, which dissolves the salts. It may be indicated by the following equation:

$$\underset{\text{Sodium acid phosphate}}{Na_2HPO_4\cdot 12H_2O}+\underset{\text{Citric acid}}{H_3C_6H_5O_7\cdot H_2O}$$

$$=\underset{\substack{\text{Sodium acid}\\ \text{phosphate}}}{NaH_2PO_4}+\underset{\substack{\text{Sodium acid}\\ \text{citrate}}}{NaH_2C_6H_5O_7}+\underset{\text{Water}}{13H_2O}.$$

This solution sometimes precipitates, and it is preferably made up fresh. Uneffloresced sodium phosphate must be used or the water may not be in sufficient amount to dissolve the salts.

Liquor Strychninæ Acetatis, *Hall's Solution*, N. F. This solution now contains about one-tenth of a grain of strychnine acetate to the fluid dram, instead of one-eighth of a grain as formerly. Strychnine combines with acetic acid, making the soluble acetate. In making salts of alkaloids, notice that the hydrogen of the acid is not displaced, but the acid is added on.

$$\underset{\text{Strychnine}}{C_{21}H_{22}N_2O_2} + \underset{\text{Acetic acid}}{HC_2H_3O_2} = \underset{\text{Strychnine acetate}}{C_{21}H_{22}N_2O_2HC_2H_3O_2}.$$

ALCOHOLIC SOLUTIONS

SPIRITS

Definition. A spirit may be defined as an alcoholic solution of a volatile substance. Spirits are sometimes called essences or flavoring extracts. Most of the spirits can be easily made by the pharmacist, being simple solutions. When volatile oils are used, the oils should be fresh and the best obtainable. Spirits usually contain from 5 to 10 per cent by volume of volatile oil. The N. F. gives a general formula for making spirits, in which 6.5 mils of volatile oil are dissolved in 93.5 mils of alcohol.

Whisky and brandy are not now official. The U. S. P. VIII required both to be four years old. Whisky is made by distilling fermented grain, and brandy by distilling fermented grape juice. Both contain acids and alcohols which slowly unite to form esters and ethers which give the flavor. The color comes largely from the wooden containers.

COMMENTS

Spiritus Ætheris Nitrosi, *Sweet Spirit of Nitre.* This spirit soon loses strength by volatilization and decomposition, and for this reason the present formula is given so that the retailer can make it up fresh frequently. It should be kept in small well-filled bottles protected from light and heat. The chemical reactions may be represented by the equations:

$$\underset{\substack{\text{Sodium}\\ \text{nitrite}}}{2NaNO_2}+\underset{\substack{\text{Sulphuric}\\ \text{acid}}}{H_2SO_4}=\underset{\substack{\text{Sodium}\\ \text{sulphate}}}{Na_2SO_4}+\underset{\substack{\text{Nitrous}\\ \text{acid}}}{2HNO_2}.$$

$$\underset{\text{Alcohol}}{C_2H_5OH}+\underset{\substack{\text{Nitrous}\\ \text{acid}}}{HNO_2}=\underset{\substack{\text{Ethyl}\\ \text{nitrite}}}{C_2H_5NO_2}+\underset{\text{Water}}{H_2O}.$$

Sulphuric acid and alcohol are diluted with water to prevent too much subsequent heat. Ethyl nitrite is practically a gas at ordinary temperature, consequently the necessity of ice. It is first washed with water to remove any alcohol that may not have been changed. Sodium carbonate is used to neutralize the excess of acid. Potassium carbonate removes water left in solution. "Concentrated nitrous ether" of different manufacturers is often used by pharmacists, and when fresh it is satisfactory; the container should be thoroughly chilled in ice water before opening. On keeping, this spirit soon becomes acid; the ethyl nitrite breaks up into alcohol and nitrous acid which oxidizes to nitric acid. Before mixing the spirit with other agents, it is often desirable to neutralize it. This is best done with sodium bicarbonate, because it neutralizes the acid but is not soluble in alcohol, consequently any excess used will settle out. This spirit would have a much more extended use if the article dispensed were always up to the standard.

Spiritus Ammoniæ Aromaticus. Commercial ammonium carbonate is a mixture of ammonium bicarbonate and ammonium carbamate, the latter being soluble in alcohol but not the former. "Translucent pieces" should be used so as to get the correct amount, because if they are opaque they have lost some ammonia and carbon dioxide, leaving a larger proportion of bicarbonate. Ammonia water converts the commercial salt into the normal carbonate.

$$\underset{\substack{\text{Ammonium bicarbonate}\\ \text{and carbamate}}}{NH_4HCO_3 \cdot NH_4NH_2CO_2} + \underset{\substack{\text{Ammonium}\\ \text{hydroxide}}}{NH_4OH} = \underset{\substack{\text{Ammonium}\\ \text{carbonate}}}{2(NH_4)_2CO_3}.$$

The mixture of ammonia water and carbonate is allowed to stand twelve hours for this reaction to take place. Later the whole mixture is allowed to stand twenty-four hours so that any excess of oils or ammonium bicarbonate may separate. This spirit slowly darkens as the ammonia acts on the oils and aldehyde in the alcohol.

Spiritus Amygdalæ Amaræ. The Pharmacopœia states that spirit of bitter almond is for medicinal use and not for flavoring food. Oil of bitter almond should contain between 2 and 4 per cent of hydrocyanic acid. For flavoring, synthetic benzaldehyde free from hydrocyanic acid may be used.

Spiritus Aurantii Compositus. Compound spirit of orange is used almost entirely in making aromatic elixir.

Spiritus Camphoræ. Dissolving 100 Gms. of camphor in alcohol increases the volume just about 100 mils, which is more than solids generally increase the volume when dissolved. Synthetic camphor differs from natural camphor in that it does not rotate polarized light.

Spiritus Glycerylis Nitratis, *Spirit of Nitroglycerin, Spirit of Glonoin.* This should be kept in cans to avoid danger of breaking the bottle. Should any spirit spill or leak out, it should be treated with a strong solution of an alkali hydroxide to decompose it. Although the spirit is not dangerous to handle, if the alcohol evaporates the nitroglycerin becomes concentrated and is then dangerous.

Spiritus Menthæ Piperitæ, *Spirit of Peppermint.* Peppermint herb is used to give the spirit a green color. If the herb is first washed with water, some yellow coloring matter is removed and a finer green is given to the preparation. For a similar reason spearmint herb is used in spirit of spearmint.

Spiritus Ætheris Compositus, *Hoffmann's Anodyne,* N. F. Ethereal oil is a solution of heavy oil of wine in ether. Heavy oil of wine is a mixture of ethyl sulphate, ethyl sulphite, and various other compounds. Much of the commercial Hoffmann's anodyne does not correspond to the N. F. article, but is a by-product in the manufacture of ether. The U. S. P. now gives Hoffmann's Drops as a synonym of spirit of ether.

Spiritus Cardamomi Compositus, N. F. This spirit and the compound spirit of vanillin are used only in making elixirs.

Spiritus Myrciæ Compositus, *Bay Rum,* N. F. This is not the same as the imported bay rum, which is said to be made by distilling bay leaves with rum. The imported has a finer odor.

Spiritus Odoratus, *Perfumed Spirit,* N. F. This was known in the previous edition as " cologne water."

ELIXIRS

Definition. Elixirs are aromatic sweetened preparations containing variable amounts of alcohol, and generally containing small amounts of active medicinal agents. The percentage of alcohol varies from about 5 to 25 per cent by volume. Manufacturers have put a large number of elixirs on the market. In order to unify these somewhat, the National Formulary, 3d ed., introduced quite a number of formulas. In the present edition there are seventy-six. The U. S. P. recognizes only aromatic elixir and elixir of glycyrrhiza.

Bases. The U. S. P. aromatic elixir is the one most frequently used. Often it is difficult to get the filtrate clear, and a larger amount of talc should be used; kieselguhr is better because the liquid filters faster and is clearer. The elixir contains about 25 per cent by volume of official alcohol. Elixir of licorice is good to cover the taste of bitter or alkaline drugs.

Aromatic red elixir contains the coloring matter from cudbear, and can be used with neutral and acid preparations; alkalies give a purplish color which is not desirable. If alkaline substances are to be dissolved in a red elixir it should be colored with carmine solution; acids cannot be used with such an elixir, because they precipitate carmine.

The N. F. gives formulas for the following elixirs, which are intended only as vehicles: Compound almond, anise, red aromatic, bitter orange, compound cardamom, aromatic yerba santa, aqueous glycyrrhiza, aromatic glycyrrhiza, compound dandelion and compound vanillin. Having so many of these is objectionable, because it requires pharmacists to keep them in stock, while two or three would answer all the purposes of physicians. The alcoholic strength of these is generally weaker than that of the aromatic elixir.

COMMENTS

Elixir Ammonii Valeratis, N. F. Ammonium valerate loses ammonia, and the free acid left makes the odor much stronger. Ammonia water is used to neutralize any free acid.

Elixir Buchu, N. F. Fluidextract of buchu when diluted with elixir gives a precipitate of resinous and other matter which talc helps to remove. By allowing it to stand for twelve hours the precipitation is more complete and the precipitate is coarser.

Elixir Calcii Bromidi, N. F. Calcium bromide may be alkaline, and acidulating the elixir makes it more palatable.

Elixir Calcii Lactophosphatis, N. F. The reactions which take place in making this are similar to those in making the U. S. P. Syrup of Calcium Lactophosphate.

Elixir Catharticum Compositum, N. F. Solution of potassium hydroxide is used to keep the resinous matter in the fluidextracts in solution, it forming soluble resin soaps.

Elixir Cinchonæ Alkaloidorum, N. F. This replaces elixir of cinchona or compound elixir of quinine which was formerly given. The title was changed to make it agree with requirements of the drug laws. It contains three of the most important of the thirty or more alkaloids found in cinchona. It has the advantage over an elixir made from cinchona in that it does not contain tannin, and so can be given with iron preparations without developing an inky color. Compound tincture of cudbear gives a color resembling that of cinchona.

Elixir Cinchonæ Alkaloidorum, Ferri, et Calcii Lactophosphatis, N. F. The elixir of cinchona alkaloids and iron contains the soluble phosphate of iron from which phosphate of iron is often precipitated by mineral acids. In order to prevent this, potassium citrate is used, as the syrup of calcium lactophosphate contains phosphoric acid.

Elixir Ferri Hypophosphitis, N. F. Potassium citrate is used in this elixir and also in Elixir of Iron Lactate to aid the solution of the iron salts.

Elixir Ferri, Quininæ et Strychninæ, N. F. This elixir will be used more than before because the elixir of iron, quinine and strychnine phosphates has been dropped on account of not being permanent. Elixirs containing the soluble phosphate of iron change and become darker. Quinine hydrochloride is used rather than the sulphate because it is more soluble.

Elixir Formatum, N. F. Potassium and sodium carbonates unite with formic acid to make formates.

$$\underset{\substack{\text{Potassium}\\\text{carbonate}}}{K_2CO_3} + \underset{\substack{\text{Formic}\\\text{acid}}}{2HCHO_2} = \underset{\substack{\text{Potassium}\\\text{formate}}}{2KCHO_2} + \underset{\substack{\text{Carbon}\\\text{dioxide}}}{CO_2} + \underset{\text{Water}}{H_2O}.$$

$$\underset{\substack{\text{Sodium}\\\text{carbonate}}}{Na_2CO_3} + \underset{\substack{\text{Formic}\\\text{acid}}}{2HCHO_2} = \underset{\substack{\text{Sodium}\\\text{formate}}}{2NaCHO_2} + \underset{\substack{\text{Carbon}\\\text{dioxide}}}{CO_2} + \underset{\text{Water}}{H_2O}.$$

Elixir Formatum Compositum, N. F. Quinine and the carbonates of the metals are converted into formates. One of the reactions is given under the elixir of formates.

Elixir Gentianæ, N. F. Gentian is one of the few vegetable drugs that contain little or no tannin, and so can be given with iron salts without much discoloration. The slight darkening that would be produced is largely prevented by the use of sodium citrate which is added.

Elixir Hypophosphitum et Ferri, N. F. Potassium citrate is used to aid the solution of ferric hypophosphite.

Elixir Pepsini, Bismuthi et Strychninæ, N. F. Elixir of pepsin and bismuth contains bismuth tartrate dissolved in a solution of sodium tartrate. Strychnine combines with tartaric acid to make the tartrate; there is no particular advantage in this over strychnine sulphate.

Elixir Pepsini et Rennini Compositum, N. F. This takes the place of the essence of pepsin, N. F. III. Pepsin may digest rennin.

Elixir Phosphori, N. F. Chloroform is a much better solvent for phosphorus than alcohol, and for that reason it is dissolved in chloroform first. Phosphorus cannot be weighed in the air because of its very rapid oxidation. A beaker of water is weighed on a balance and a piece of phosphorus which is thought to be about the right weight put into the water and accurately weighed, although it may not be the correct amount wanted. The phosphorus is dissolved in chloroform and enough of the solvent added to make a certain volume and an aliquot part of this solution is used.

Elixir Terpini Hydratis, N. F. The formula as given in the N. F. III made a preparation which gave trouble because terpin hydrate, or more often sugar, crystallized out. Terpin hydrate is sparingly soluble in water, and to prevent precipitation so much alcohol was used that the sugar crystallized from syrup. The trouble is now remedied by using a little more alcohol and some water in place of part of the syrup.

FLUIDEXTRACTS

Definition. A fluidextract is a solution of the active principles of a vegetable drug, of such strength that one milliliter of the solution represents one gram of a drug of good quality. The U. S. P. directs that some fluidextracts be made up to a certain alkaloidal strength, but this corresponds to a good drug. The word "fluidextractum" was coined so that the Latin names of these preparations would come together and not be mixed with those of the solid extracts. The U. S. P. recognizes forty-eight, and the N. F. ninety, fluidextracts.

Menstruums. The menstruum is generally alcohol or alcohol and water, sometimes with the addition of glycerin, acetic acid, hydrochloric acid, ammonia, or potassium hydroxide. Sometimes the drug is exhausted with either cold or hot water, and alcohol is added to the concentrated percolate. In the U. S. P. VIII, three fluidextracts (lobelia, sanguinaria, and squills), were made with a menstruum of acetic acid and water. While this is a good solvent for some active principles, the preparations were too acid to be satisfactory. Some years ago Dr. Squibb introduced fluidextracts made with dilute acetic acid and called them "acetracts." To exhaust a drug, from two to five times as much percolate must be obtained as drug used. As the finished fluidextract is stronger than this percolate, it is necessary to extract the drug as carefully as possible. For this reason the subject of percolation is here taken up in detail.

Requirements. To make a good fluidextract it is necessary: 1. To get a good drug. It is often difficult to detect adulteration or the presence of a poor drug, particularly when the drug is powdered, as it now always is when bought by the retail pharmacist. Drugs should be bought from firms whose honesty cannot be questioned. 2. The drug should be of the right degree of fineness and the particles should be uniform in size, because if not they will not be evenly exhausted. The fineness required depends upon the texture of the drug and the menstruum used. If the drug is hard and horny, or if the active principles are difficult to extract, or the menstruum is strongly alcoholic, it should be fine. If the drug is loose and porous, or if the active principles are easily dissolved, or if the menstruum contains considerable water, it should be in a coarser powder. Dilute alcohol causes much more swelling and packing of the drug than does strong alcohol. 3. The menstruum should be such that it will readily dissolve the active principles without loading the percolate unnecessarily with inert matter. Drugs having as their active principles oils, resins, or alkaloids combined with tannic acid generally require stronger alcohol than if the active principle is a glucoside or bitter principle. It is necessary to know the properties of the drug in order to get the correct menstruum. 4. Having a good drug, properly ground, and the best menstruum, the drug is dampened with a part of the menstruum and preferably allowed to stand in a covered vessel for six hours or longer to let it swell before being put into the percolator. The dried drug is something like a piece of sponge; it at first repels the menstruum and then absorbs it and swells. By letting it swell before packing in a percolator it is much easier to determine the right degree of firmness with which to pack it. Dampening the powder before putting into the percolator also prevents the fine particles from being washed down to the bottom of the column and clogging the flow of menstruum. 5. A small wad of cotton or a perforated diaphragm is put into the neck of the percolator and the dampened drug put in in portions, packing after each addition so as to give about the same degree of firmness to the whole column of drug. It should not be quite as tightly packed in the lower part as in the upper, because the liquid becomes thick and viscid as it passes downward. Packing can be learned only by practice. 6. A sieve or piece of filter paper is placed on top of the drug and weighted down to prevent washing cavities in the drug when the menstruum is poured on. 7. The menstruum is poured on until the drug is saturated and there is a layer on top. There should be a layer of menstruum on top continuously. As soon as the menstruum reaches the bottom of the drug, the opening at the lower end of the percolator should be closed, but if it is closed before that time, air will be held between the particles and will prevent the liquid from coming in contact with all of the drug. 8. The percolator is then covered and the drug macerated for forty-eight hours to allow the menstruum time to dissolve out the active principles. 9. Percolation is allowed to proceed slowly. For fluidextracts, the U. S. P. directs not over ten drops of percolate per minute for each kilogram of drug. A more rapid flow, twenty drops per minute, is allowed in case of tinctures, because of the much larger proportion of solvent. Fresh menstruum must be added as soon as that previously added reaches the top of the drug. If it gets below the top of the drug, the menstruum added next will pass between the particles of drug, washing off the active principles on the outside without entering the particles. 10. The percolation is continued until a certain volume of percolate is obtained, generally, 750, 800, or 850 mils for 1000 Gms. of drug. This is set aside and the percolation continued until the drug is exhausted. The amount of first percolate set aside varies because the amount of solid extract in the second percolate varies with different drugs. When this amount of solid matter is large, the amount of the first percolate received must be small. The first percolate contains from 70 to 80 per cent of the active matter, and this is not heated or injured. 11. A knowledge of the properties of the drug is necessary in order to know when it is exhausted. If the drug yields a large amount of coloring matter, carry the percolation until the percolate is nearly colorless; if bitter, until the percolate is nearly tasteless; if resinous, until the percolate when dropped into water does not produce a turbidity. 12. The second percolate is evaporated to a soft extract. In evaporating, the alcohol comes off first. The water must also be evaporated or it would cause precipitation when added to the reserved percolate by diluting the alcohol. There is generally a turbidity any way, because the heat used in evaporating the second percolate changes some of the inert matter so that it is no longer soluble.

In order to avoid the necessity of repeating directions so often, the U. S. P. gives four type processes and refers the manufacturer to these. Special directions are given for a few drugs. Under "Type Process A," are put the fluidextracts which are made by the regular method of percolation, using a constant menstruum of alcohol or a mixture of alcohol and water throughout the process. About 73 per cent of the U. S. P. and N. F. fluidextracts come under this class.

Under "Type Process B" are classed the fluidextracts made by the regular method of percolation, using two menstruums, the first consisting of glycerin or acid with alcohol and water, and the second of alcohol and water alone. Glycerin is not readily volatilized, and if it were used throughout the percolation, the second part of the percolate could not be evaporated down to the required amount. Glycerin is generally used to prevent subsequent precipitation of the fluidextract, although it has some solvent effect on the drug. If acid were used during the whole percolation, there would be danger of its injuring the active principles when evaporating the second percolate.

Acid is used to make alkaloids more soluble and permanent. Ten U. S. P. and thirteen N. F. fluidextracts come under this class.

Under " Type Process C " are classed the fluidextracts which are made by fractional percolation or repercolation. This method is to be used when drugs contain volatile principles or principles easily injured by heat. Fluidextracts made by this method do not precipitate much on standing because extractive matter has not been changed by heat. The fluidextracts made by fractional percolation are aconite, aromatic, bitter orange peel, and conium N. F.

Under " Type Process D " are put the fluidextracts made by extracting the drug with hot water, concentrating and adding alcohol as a preservative. Alcohol also causes precipitation of inert matter which can be removed by allowing to settle. Fluidextracts made by this method are cascara, frangula, triticum, and chestnut N. F.

In a few cases special directions are given, as in making fluidextracts of aromatic cascara, glycyrrhiza, senega, and squills, and the N. F. fluidextracts of aqueous cinchona and wild cherry.

Fluidextracts should be kept in stock for several months before bottling, as precipitation of inert matter goes on slowly. Generally they should not be filtered, because in doing so some alcohol evaporates which changes the solvent and further precipitation results. They should be kept in a cool place not subject to much change in temperature, and protected from light. The fluidextracts assayed biologically are aconite, cannabis, digitalis, squills, and apocynum, N. F.

COMMENTS

Fluidextractum Aconiti. The fractional method of percolation is used because the alkaloids are injured by heat. The amount of alkaloids is determined by a chemical method, and a standard is also given for a biological assay.

Fluidextractum Belladonnæ Radicis. Both belladonna root and leaves are official, but they are not of the same strength. It is necessary that the title show from which part of the plant the preparation is made.

Fluidextractum Cannabis. This is assayed biologically. Cannabis deteriorates rapidly, and care should be taken to get a good drug. The fluidextract keeps better than the crude drug. Not more than a low heat should be used in making it.

Fluidextractum Cascaræ Sagradæ Aromaticum. Treating cascara with magnesium oxide and water gets rid of much of the bitter principle, and what is left is largely covered up by saccharin and volatile oils.

Fluidextractum Cinchonæ. Hydrochloric acid makes the alkaloids more soluble, and glycerin lessens subsequent precipitation. Cinchona is now assayed for total alkaloids and not ether-soluble ones.

Fluidextractum Colchici Seminis. Colchicum seed, like other seed, contain a fixed oil. This is removed by percolating the drug with benzin.

Fluidextractum Ergotæ. Hydrochloric acid makes the active principles more soluble and more permanent.

Fluidextractum Glycyrrhizæ. Ammonia in the menstruum makes the glycyrrhizin more soluble and sweeter. Chloroform water is used in preference to plain water because the chloroform is a preservative; most of it is ultimately volatilized.

Fluidextractum Nucis Vomicæ. Nux vomica contains a considerable amount of fatty matter which is taken out in making the fluidextract. It is not volatilized in evaporating the second percolate, and the excess separates from the finished preparation, forming a layer on top. It would be better if the U. S. P. directed its removal, as is done in case of the solid extract. Or, it can be removed by chilling and filtering as directed under the fluidextract of staphisagria. The fluidextract is now made up to a definite amount of total alkaloids instead of strychnine, as formerly.

Fluidextractum Scillæ. Squill is difficult to percolate, because it contains so much mucilaginous matter. The method of alternate maceration and percolation is used to better extract the drug. By mixing the concentrated percolate with two and one-half times its volume of alcohol, considerable mucilaginous matter is precipitated and later removed. The filtrate is evaporated to get rid of the excess of alcohol, and is then brought back to the correct amount. This extract is assayed biologically.

Fluidextractum Senegæ. Senega contains pectinous matter which is dissolved out and later may make a gelatinous mass. Ammonia is put in to prevent gelatinization. Potassium hydroxide was used in U. S. P. VIII instead of ammonia, and is better in that it does not volatilize.

Fluidextractum Sennæ. The U. S. P. VIII directed the removal of the resinous matter by first percolating with strong alcohol and later with dilute alcohol, which dissolved the acting principles. The resinous matter is said to have a griping effect.

Fluidextractum Staphisagriæ. Stavesacre contains a fixed oil which the U. S. P. directs to be removed by chilling the preparation and filtering.

Fluidextractum Castaneæ, N. F. Chestnut leaves are exhausted with boiling water. Alcohol is added to the concentrated percolate to precipitate albuminous matter. The alcohol in the finished preparation is only about 20 per cent, but 10 per cent by volume of glycerin is present, sufficient to keep it.

Fluidextractum Cinchonæ Aquosum, N. F. Hydrochloric acid converts the alkaloids into more soluble compounds. The fluidextract contains no alcohol and only about 12.5 per cent of glycerin. Quinine is itself somewhat of an antiseptic.

Fluidextractum Conii, N. F. The alkaloid coniine is volatile, and acetic acid is added to convert it into the acetate, which is more permanent.

Fluidextractum Pruni Virginianæ, N. F. The U. S. P. VIII directed the fluidextract of wild cherry to be made without any evaporation, stopping percolation when the required volume was reached, as benzaldehyde and hydrocyanic acid are volatile. The addition of the residue from the second percolate as directed by the N. F. adds little if any medicinal matter to the reserved percolate.

Fluidextractum Sanguinariæ, N. F. Citric acid is used in fluidextract of bloodroot to make the alkaloids soluble. Formerly hydrochloric acid was used.

FLUIDGLYCERATES

Fluidglycerates are similar to fluidextracts except no alcohol is used. The N. F. gives a general formula in which the menstruum is a mixture of one volume of glycerine with two volumes of water, followed by chloroform water. Five hundred mils of percolate are set aside, and the balance evaporated to 600 mils and then all of it evaporated to 1000 mils. In this treatment all of the chloroform is driven off and the albuminous matter is precipitated. These preparations are expected to have the same strength as fluidextracts.

Fluidglyceratum Cascaræ Sagradæ Aromaticum, N. F. Calcium oxide is used for the same purpose as magnesium oxide in the U. S. P. aromatic fluidextract of cascara, to get rid of the bitter principle.

TINCTURES

Definition. A tincture may be defined as an alcoholic or hydro-alcoholic solution of a non-volatile or only partly volatile substance. The tinctures of bitter orange, sweet orange, lemon, and iodine contain volatile principles. U. S. P. tinctures are made from vegetable drugs, excepting those of cantharides, musk, iron, and iodine.

Methods of Making. The majority of tinctures are made by maceration and percolation, the general formulas or type processes being given. Two U. S. P. tinctures, iron and iodine, and ten N. F. tinctures are made by simple solution. The method of maceration and filtration is used when the drug is very resinous and difficult to percolate because of the large amount of soluble matter, or when the drug is in a fresh, undried condition, or where there is a comparatively small proportion of drug. Digestion might be used in some cases to shorten the period of maceration. Some druggists make tinctures by diluting fluidextracts, but this is not generally advisable, except in case of some of the rarer tinctures and when the menstruum for the tincture is the same as that for the fluidextract, or in some cases of assayed fluidextracts. The menstruums for tinctures are generally the same as those for the corresponding fluidextracts, or are weaker in alcohol. The large proportion of menstruum, although weaker in alcohol, may be sufficient to exhaust the drug. Glycerin is used for its solvent action and to lessen subsequent precipitation, particularly in case of drugs containing much tannic acid. The drug strength of most tinctures is either 10 Gms. or 20 Gms. of drug to 100 mils of the finished product. Using this proportion of menstruum to drug exhausts the drug by the time the amount of tincture wanted is obtained, and no evaporation is necessary.

COMMENTS

Tinctura Aconiti. In the U. S. P. VII, the strength of this tincture was three and one-half times what it now is. It is assayed for ether-soluble alkaloids, and a standard is also given for the biological assay.

Tinctura Aloes. With glycyrrhiza in the formula as given, this tincture can be made by percolation, although the maceration method is directed. Licorice also lessens the bitter taste.

Tinctura Arnicæ. The directions differ from the two type processes. The alternate percolation and maceration is for the purpose of better exhausting the drug. If the flowers are thoroughly dampened, they can be packed in the percolator so that they can be exhausted by slow percolation. The flowers are bulky and in the previous Pharmacopœia, pressure was directed so as to lose less menstruum.

Tinctura Aurantii Amari, *Tincture of Bitter Orange.* This tincture is made by percolation of the dried, ground, unripe peel. It contains more iron-coloring substance than the tincture of sweet orange.

Tinctura Aurantii Dulcis, *Tincture of Sweet Orange.* This tincture replaces the spirit of orange formerly official, because it has a finer flavor. The inner white part of the fresh peel is removed, as it contains tannin or other iron-coloring substance. The maceration method must be used with the fresh peel.

Tinctura Benzoini Composita. This is similar to several proprietary preparations as Friar's balsam, Jesuit's balsam, Turlington's balsam, etc.

Tinctura Cannabis. This tincture is assayed biologically.

Tinctura Cantharidis. Maceration at a temperature of from 50° to 55° C. aids the exhaustion of the fly. A flask is better than a can for this. A glass tube is used to condense the vaporized alcohol and avoid loss.

Tinctura Digitalis. This is assayed biologically.

Tinctura Ferri Chloridi. The mixture of alcohol and solution of ferric chloride is allowed to stand for three months to allow the reaction between the free acid and alcohol to take place. Some chloric ether and other compounds are formed; these have little if any therapeutic value in the amounts formed, and the writer sees nothing gained by the standing. If the solution has only a slight excess of free hydrochloric acid, a basic ferric chloride is slowly precipitated, the acid being used up by the alcohol. To remedy this the clear supernatant liquid should be decanted and just enough of hydrochloric acid added to the residue to dissolve the precipitate and this is then mixed with the portion decanted. The tincture should be protected from light because in the presence of alcohol the ferric salt is reduced to ferrous.

Tinctura Gambir Composita. This tincture replaces the compound tincture of catechu, as true catechu is no longer obtainable. Cinnamon is put in to improve the taste and aid filtration.

Tinctura Gentianæ Composita. Gentian contains practically no tannin or iron-coloring matter, but tannin gets into this tincture from the orange peel and cardamom used.

Tinctura Guaiaci Ammoniata. This and the Ammoniated Tincture of Valerian are made with aromatic spirit of ammonia as the menstruum, hence both are alkaline.

Tinctura Iodi. Potassium iodide aids the solution of iodine and prevents precipitation when water is added to the tincture. Potassium iodide is said to retard the reduction of iodine to hydriodic acid, but no explanation is offered; potassium iodide in solution slowly liberates iodine, and possibly this takes the place of the iodine changed to hydriodic acid. In the formula given in the U. S. P. VIII, difficulty was experienced in getting potassium iodide dissolved in alcohol, but this is now obviated by dissolving it in water.

Tinctura Kino. The active principle of kino is kinotannic acid, which is quite readily dissolved in hot water. This tincture is very liable to make a solid gelatinous mass, the formation of which is retarded by keeping the tincture in a cool place, in small well-filled bottles, protected from air. The gelatinization is due to an enzyme, which is probably destroyed by the heating for an hour, so that the tincture keeps better now.

Tinctura Lactucarii. Sand is used to cut up the lactucarium and aid percolation. Benzin takes out caoutchouc-like matter, leaving the active principles. The tincture is used in making the syrup, and if the tincture is well made it will mix practically clear with glycerin and syrup. So much drug is used in proportion to the menstruum that evaporation of a part of the percolate is necessary.

Tinctura Limonis Corticis. This tincture takes the place of the former spirit of lemon, having a finer flavor. It might be classed as a spirit, for it is practically an alcoholic solution of a volatile substance.

Tinctura Moschi. Musk is triturated with water, as water takes out more of the extractive matter than alcohol, but alcohol is used as a preservative, and also to make the tincture mix better with other alcoholic liquids. It is used largely in making perfumes, to give a lasting effect.

Tinctura Nucis Vomicæ. In the U. S. P. VIII this tincture was made by dissolving a standardized solid extract, but it is now made by percolating the crude drug.

Tinctura Opii, *Laudanum.* The alkaloids in opium are chiefly in combination with sulphuric and meconic acids, and these salts are soluble in water. Water disintegrates opium better than alcohol does. The official method of making laudanum often does not exhaust the opium. A better method is to extract the opium with water until completely exhausted, as is done in making tincture of deodorized opium; concentrate the water extract, add alcohol, filter, and make up to the right amount. Gum opium can be used in place of the granulated, provided the finished product is brought up to the right morphine strength. Laudanum now contains from 0.95 Gm. to 1.05 Gms. of anhydrous morphine in 100 mils, equivalent to from 1.01 Gms. to 1.11 Gms. of morphine with one molecule of water of crystallization. The former strength was from 1.25 Gms. to 1.5 Gms. of crystallized morphine.

Tinctura Opii Camphorata, *Paregoric.* The strength is not necessarily indicated by the color, as this varies even when made from the same sample of opium. Paregoric can be made up more quickly by using 40 mils of laudanum in place of 4 Gms. of opium.

Tinctura Opii Deodorati. Benzin takes out much of the odoriferous resinous matter. If benzin is shaken vigorously with the water extract, an emulsion is likely to form and this is difficult to break up. All traces of the odor of benzin must be removed. A method which is more satisfactory, less troublesome, and gives a less odorous product, is to shake the water extract vigorously with melted paraffin. Allow the paraffin to cool, when it can be removed without trouble. This tincture is thought to be less nauseating than laudanum. Ether was used at one time, but it took out part of the narcotine.

Tinctura Sanguinariæ. Hydrochloric acid is used in making tincture of blood root to aid the solution of sanguinarine and to retard or prevent subsequent precipitation. The reason is not plain why hydrochloric acid is used here and citric acid with N. F. fluidextract.

Tinctura Scillæ. On account of squills containing so much mucilaginous matter, it is difficult to percolate, although it is not packed; the method of macerating, straining, and filtering must often be followed. With a strong alcoholic menstruum the percolation is not so difficult.

Tinctura Strophanthi. Strophanthus contains a fixed oil which is objectionable because of its tendency to produce vomiting and diarrhœa. It is removed by percolating the drug with benzin first. It can be removed from the tincture by chilling the tincture in an ice mixture and filtering.

Tinctura Aloes et Myrrhæ, N. F. Glycyrrhiza is used to aid filtration and to cover up the bitter taste of aloes.

Tinctura Antiperiodica, *Warburg's Tincture,* N. F.

This seems to be a relic of the " shot gun " prescription age. The tincture without aloes is also recognized, but it should be specified when wanted.

Tinctura Cacti Grandiflori, N. F. The fresh succulent stems of the wild plant are used. The strength must necessarily vary because of the difference in the amount of moisture present. It would be better to make the tincture up to a definite strength calculated from the dried drug.

Tinctura Caramellis, N. F. Caramel varies greatly in color and so does the tincture. Considerable work has been done in attempting to standardize caramel preparations, but so far with little satisfaction.

Tinctura Ferri Chloridi Ætherea, *Bestuscheff's Tincture, Lamotte's Drops*, N. F. Direct sunlight in the presence of alcohol and ether reduces ferric iron to ferrous, and subsequent exposure to air and removal from sunlight partially oxidizes it again. The finished product is a variable mixture of ferric and ferrous chlorides. During the process of reduction there are some esters and ethers undoubtedly formed. This tincture is about one-sixth as strong in iron as the official tincture.

Tinctura Ferri Citro-Chloridi, *Tasteless Tincture of Iron*, N. F. Chemical reaction takes place by which a part of its ferric chloride is changed to citrate. The color changes to a dark green; probably a double compound is formed. This tincture is one which can often be used advantageously in place of the U. S. P. tincture because it does not give nearly as many incompatibilities, the citrate present preventing them. It deserves more attention than is given it. The iron strength of the two tinctures is the same, but not the alcohol strength. The saline matter which separates is sodium chloride, thrown out of solution by alcohol. Although called tasteless, it is not tasteless, but does not have the styptic taste that the other tincture has.

$$\underset{\text{Ferric chloride}}{FeCl_3} + \underset{\text{Sodium citrate}}{Na_3C_6H_5O_7} = \underset{\text{Ferric citrate}}{FeC_6H_5O_7} + \underset{\text{Sodium chloride}}{3NaCl}.$$

Tinctura Guaiaci Composita, *Dewee's Tincture of Guaiac,* N. F. Potassium carbonate combines with some of the resin in guaiac, making a soluble resin soap. Should an acid be added to the tincture a large amount of resin would be precipitated.

Tinctura Iodi Decolorata, N. F. The title of this tincture is a misnomer, as it would lead one to think that free iodine is present. Iodine exists here only in combination, chiefly as the iodides of sodium and ammonium with a little iodate. The tincture does not have the effect of iodine, when applied. Sodium thiosulphate reduces a part of the iodine and the ammonia the balance. The equations below indicate the reactions. On standing for some time, there is a separation of a little crystalline matter or a heavy liquid; probably a slight variation in proportion of ingredients causes the difference, as some students get crystals while others using the same materials get the liquid. The crystals are said to be sodium tetrathionate, and the liquid is undoubtedly a sulphur compound.

$$\underset{\text{Iodine}}{2I} + \underset{\text{Sodium thiosulphate}}{2Na_2S_2O_3} = \underset{\text{Sodium iodide}}{2NaI} + \underset{\text{Sodium tetrathionate}}{Na_2S_4O_6}.$$

$$\underset{\text{Iodine}}{6I} + \underset{\text{Ammonium hydroxide}}{6NH_4OH} = \underset{\text{Ammonium iodide}}{5NH_4I} + \underset{\text{Ammonium iodate}}{NH_4IO_3} + \underset{\text{Water}}{3H_2O}.$$

Tinctura Ipecacuanhæ et Opii, *Liquid Dover's Powder,* N. F. It is rather more convenient to evaporate the tincture to a given weight than volume. Fluidextract of ipecac, being made with a stronger alcohol, gives a precipitate when mixed with the residue, and this precipitate must be filtered out and the filter washed. To get room for the wash liquid, the tincture is evaporated to 700 Gms. instead of to 900 mils.

Tinctura Jalapæ Composita, N. F. Sand is used to aid percolation because the large amount of resinous matter would otherwise make a mass that would be hard or impossible to percolate. Sand can be used to advantage in many percolations.

Tinctura Kino et Opii Composita, N. F. Cochineal is used to give color. Ammonia makes the coloring matter more soluble.

Tinctura Opii Crocata, *Sydenham's Laudanum*, N. F. The morphine strength of this tincture is the same as that of laudanum. Sand is used to aid percolation.

Tinctura Persionis Composita, *Compound Tincture of Cudbear*, N. F. Caramel with cudbear makes a brown-red color. This tincture is used to give color to neutral or acid liquids. It gives an undesirable purplish color with alkalies.

Tinctura Quillajæ, N. F. The bark is boiled with water to get out the saponin. Alcohol added to the cooled concentrated liquid precipitates inert matter. This tincture gives a foam when shaken.

Tinctura Rhei Aquosa, N. F. Potassium carbonate combines with the resinous matter in rhubarb, making a soluble compound. The amount of alcohol present is so small that it would hardly preserve the preparation, but the alkali and cinnamon water also help.

Tinctura Vanillæ, N. F. The beans should be cut into small pieces with a shears or sharp-knived meat chopper so that they will not be bruised to a mass until after being extracted by alcohol. Maceration with alcohol and water makes the beans softer so that they can be more readily disintegrated when pounded with sugar. The liquid also takes out some matter so that the mass formed on pounding is more easily percolated. Sugar helps to cut up the bean. Maceration for several months improves the flavor.

Tincturæ Æthereæ, N. F. The N. F. gives a general formula for making ethereal tinctures, using 10 Gms. of drug and enough of a mixture of one volume of ether and two volumes of alcohol to make 100 mils. The mixture of ether and alcohol dissolves out matter slightly different from that taken out by alcohol alone, but aside from the effect of the ether, the ethereal tinctures have about the same therapeutic action as the others.

Tincturæ Medicamentorum Recentium, *Tinctures of Fresh Herbs*, N. F. The drug strength and the alcohol strength of a given tincture vary at different times because of the variation of the amount of water in the fresh drug. Although 50 Gms. of drug are directed for 100 mils of tincture, the tincture may really not be very strong because of the large amount of water. The tincture of cactus grandiflorus N. F. is an example of a tincture of a fresh herb.

WINES

Definition. Medicated wines are preparations containing chemicals or active principles of drugs dissolved in wine or fortified wine. Wine is generally strengthened by the addition of from 5 to 15 per cent of alcohol, making a better solvent and preservative. The Pharmacopœia does not now recognize any wines.

Kinds. Although wines in general include fermented juices from all sweet fruits, as apples, peaches, pears, and blackberries, the N. F. designates that from the juice of grapes. White wine is made from the juice of light-colored grapes after the skins, seeds, and stems have been removed. It contains only a small amount of tannin. Red wine is made from dark-colored grapes, fermentation taking place with the skins and seeds left in. It contains considerable tannin, and should not be used with iron preparations, and is not as good in making medicated wines. Wine can be detannated by shaking with powdered gelatin, the tannin combining with the gelatin to make an insoluble compound. Milk has been used, the tannin combining with casein. Ferric hydroxide is objectionable as a detannating agent, because it may be partly dissolved by the acid tartrate present. The acidity is due largely to potassium bitartrate.

A dry wine is one made from a juice in which sugar and ferment are present in considerable amount and in relative proportions to give a strong wine without marked sweetness or acidity. A sweet wine is obtained from a juice containing a large proportion of sugar to the ferment. A rough or astringent wine is one that contains tannic acid in sufficient amount to produce its effect. A light wine is one that is comparatively weak in alcohol.

COMMENTS

Vinum Xericum, *Sherry Wine*, N. F. This is a white wine, and the only one directed to be used in making medicated wines. It contains from 16 to 24 per cent of alcohol by volume, and has been fortified with pure grape brandy.

Vinum Carnis et Ferri, *Beef, Iron and Wine,* N. F. This preparation was once a favorite one. Many formulas have been proposed for it. The trouble with most of them is that a precipitate of albuminous matter continues to deposit for weeks, making a muddy mixture.

Vinum Colchici Cormi, N. F. Attention is called to the strength of this wine, 100 mils representing 40 Gms. of drug. The wine of the seed is only a little over one-fourth as strong, and the dispenser should be sure that he knows which wine the physician wants. Colchicum seed contains 0.1 per cent more colchicine than the corm.

Vinum Picis, *Wine of Tar,* N. F. Tar is washed with water to take out some phenols and other objectionable compounds. It is mixed with pumice stone so that the wine will have a better chance to dissolve it.

Vinum Pruni Virginianæ, N. F. During the maceration of wild cherry bark with water, amygdalin is decomposed by a ferment, making benzaldehyde and hydrocyanic acid.

Vinum Opii. This is not now recognized by the U. S. P. or N. F. It has been prescribed as Sydenham's laudanum. It was of the same strength as tincture of opium.

Vinum Pruni Virginianæ Ferratum, N. F. The tincture of citro-chloride of iron is preferred to the U. S. P. tincture because it does not give as much black inky ferric tannate.

MISCELLANEOUS

SOLID EXTRACTS

Definition. Solid extracts are preparations containing the active principles of vegetable drugs (except oxgall), made by evaporating a solution to the consistency of a thick liquid, a pilular mass, or to a dry powder. Extract of malt is the only official liquid extract. In cases of belladonna and stramonium both pilular and powdered forms are recognized. Extracts of pilular consistency are more convenient for making ointments and pill masses, while the powdered extracts are generally more easily weighed out and used at the prescription counter, and change less on keeping.

The amount of moisture in pilular extracts differs considerably even in extracts from the same drug. It is difficult to bring the evaporation to the same point with each lot; manufacturers differ in their opinions of pilular consistency; extracts take up and give off moisture; they are harder in winter than in summer. They should be kept in small containers and well protected from light and exposure. When a diluent is needed the U. S. P. directs the use of glucose.

In making powdered extracts the menstruum is entirely evaporated and the residue made up to the right strength by the addition of starch or starch with magnesium oxide. The U. S. P. also allows the use of sugar, milk sugar, glycyrrhiza, magnesium carbonate, or the finely powdered drug or marc from which the extract was made. Theoretically, magnesium oxide is not a good agent to use because of its alkalinity and tendency to break up the alkaloidal salt, even decompose the active principles, and unite with resinous matter. If a drug contains much oil which would be dissolved by the menstruum, it is necessary to first remove the oil, as it would prevent the making of a dry powdered extract. Benzin is a good solvent for oils, but not for most of the active principles of plants. Powdered extracts should be well protected from air, light and heat; many of them absorb moisture and then cake.

Method of Making. The general method of making extracts is similar to that of making fluidextracts, except that the evaporation is carried further. With improved vacuum stills, evaporation can be carried on at a temperature which will not decompose the active principles. Evaporation is greatly facilitated by stirring. The menstruum used in making a solid extract is about the same as that in making the corresponding fluidextract, or then weaker in alcohol. In some cases water is the menstruum, and as the water is nearly all evaporated, the residue does not generally need a preservative, although glycerin is sometimes added to keep it from molding, or from drying out and becoming tough. If water is used, cold water is generally better than hot, as it does not dissolve out as much starch and inert matter and is not as likely to cause injury to the active principles. The U. S. P. directs the extract of cascara to be made with hot water; and the N. F. directs to boil the wood with water in making extract of logwood. In case of some extracts the water solution is boiled to coagulate albuminous and inert matter which is subsequently filtered out, and the extract thus purified. If the drug being extracted is a leaf, the chlorophyll will be coagulated and removed by filtration, and the preparation will not have as fine a green color. Extracts may darken on keeping because of oxidation of inert matter. Light often destroys the green color of leaf extracts. When a prescription calls for an extract not generally carried in stock, the extract can often be made without objection by evaporating some of the fluidextract.

Many extracts are now made up to a standard in reference either to the alkaloidal content or to the crude drug. Of the twenty-seven U. S. P. extracts, eleven are made to a definite strength of alkaloids and seven to a definite proportion of crude drug. Of the twelve N. F. extracts, three are assayed for alkaloids and five are made up to a definite proportion of drug.

COMMENTS

Extractum Aconiti. Tartaric acid is used to convert the alkaloids into more soluble compounds. In the evaporation of the percolate, tartaric acid is not as likely to injure the alkaloids as a mineral acid. A glass percolator is directed, as the acid would tend to dissolve a metallic one. After evaporating off the alcohol from the percolate, the residue is shaken with petroleum ether to remove fatty matter which has been taken out by the menstruum. The extract is about four times the strength of a good crude drug, and contains about 2 per cent of alkaloids.

Extractum Belladonnæ Foliorum. Both belladonna leaves and roots are official but are not of the same strength. It is necessary to show by the title that the extract is made from leaves. The tincture is also made from the leaves, but the fluidextract from the root. The extract contains about 1.25 per cent of alkaloids and is about four times as strong as the crude drug. Both powdered and pilular extracts are official.

Extractum Cannabis. This is an extract which the retail druggist cannot well make as the U. S. P. directs that it be assayed physiologically. The extract is seven and one-half times as strong as the fluidextract or a good drug. The active matter is easily injured, and as little heat as possible should be used.

Extractum Cascaræ Sagradæ. Hot water exhausts the drug better than cold water. The extract is three times the strength of the drug. Magnesium oxide removes the bitter principle to some extent.

Extractum Colchici Cormi. Since the corm contains some fatty matter that would interfere with making a dry powdered extract, the concentrated percolate is shaken with benzin to remove it. Both colchicum corm and seed are official, consequently the word corm occurs in the title. This extract is about four times the strength of a good drug, and contains about 1.4 per cent of colchicine.

Extractum Colocynthidis. The U. S. P. in describing colocynth now directs that it contain not more than 5 per cent of seed. Seed contains but little of the bitter principle, and considerable oil, and if the oil were in the percolate, a dry extract could not be obtained. This extract is used only in making the compound extract, and is four times as strong as the crude drug.

Extractum Ergotæ. Ergot contains quite a large per cent of fatty matter which has no therapeutic value and is objectionable in the extract. This is removed by benzin. Hydrochloric acid aids the solution of the active principles, and also makes them more permanent. The extract keeps better than the crude drug. It is not assayed or made up to a given proportion to the amount of drug used, consequently the strength of different samples will vary.

Extractum Fellis Bovis, *Extract of Oxgall.* Alcohol precipitates considerable albuminous matter which, if left in, would make the dried product inert, tough, and difficult to use. This extract is eight times the strength of the fresh gall.

Extractum Gentianæ. Cold water exhausts gentian. Boiling the percolate coagulates albuminous matter that is dissolved by water, and the precipitate is filtered out. If hot water were used in percolating the root, the extract would weigh nearly twice as much, but would be only one-half as strong, because hot water takes out so much inert matter.

Extractum Glycyrrhizæ Purum. Ammonia makes the glycyrrhizin more soluble and sweeter. The latter part of the percolation is made with chloroform water. If plain water is used there is great danger of fermentation commencing before the drug is exhausted. The chloroform in the water acts as a preservative, and is volatilized in concentrating the percolate. The commercial extract which is recognized is quite impure, often containing a large percentage of insoluble matter.

Extractum Hydrastis. Tartaric acid is used to aid the solution of the alkaloids. The extract made up to 10 per cent of alkaloids is about four times as strong as the drug.

Extractum Malti. Malt contains a diastatic ferment which would be rendered inert at the temperature of a water-bath, consequently care should be taken to keep the temperature about that prescribed by the U. S. P. It is the only liquid extract recognized.

Extractum Nucis Vomicæ. Nux vomica contains quite a large amount of fixed oil which, if left in, would prevent the making of a dry, powdered extract. The oil is removed by benzin, and with it some of the alkaloids. The separated benzin extracts are mixed and shaken with acidulated water, the acid converting the alkaloids into sulphates which are soluble in water but not in benzin. The water containing these sulphates is shaken with ammonia and then chloroform, the ammonia liberating the alkaloids which, being only sparingly soluble in water and readily soluble in chloroform, go to the chloroform. The chloroform is evaporated with the extract and the alkaloids, which the benzin took out, are thus brought back into the extract. The extract made up to 16 per cent of alkaloids is between six and seven times as strong as the drug.

Extractum Opii. Sand is used to help percolation. Opium can be exhausted with water because the alkaloids are in combination with sulphuric and meconic acids, and the salts are soluble. The U. S. P. uses gum opium, but granulated opium may be used as it was in the previous Pharmacopœia, the finished product being made up to 20 per cent of anhydrous morphine.

Extractum Physostigmatis. Tartaric acid is used to aid the solution of alkaloids, and benzin is used to take out the fixed oil. It contains 2 per cent of alkaloids, and is about thirteen times as strong as the drug.

Extractum Stramonii. Both pilular and powdered extracts are official. They contain 1 per cent of alkaloids, and are four times as strong as the leaves.

Extractum Aloes, N. F. Hot water dissolves out the active matter more readily than cold. Aloes contains a large proportion of matter soluble in water, and a strong solution of this is a good solvent for inert resinous matter. A large amount of water is used so as to get a dilute solution that will not dissolve much resinous matter.

Extractum Conii, N. F. The active principle, coniine, is a volatile alkaloid. The N. F. directs the addition of hydrochloric acid to that portion of the percolate which is to be evaporated, as the hydrochloride of coniine is not volatile.

Extractum Ergotæ Aquosum, N. F. Ergot is extracted with chloroform water, the chloroform acting as a preservative and preventing fermentation during the making. Alcohol added to the concentrated water extract precipitates inert matter, which is filtered out.

Extractum Ferri Pomatum, *Crude Malate of Iron*, N. F. The fresh apple juice to be used comes from sour apples, and contains malic acid, which acts upon the iron, dissolving it and making soluble iron malate.

Extractum Hæmatoxyli, N. F. Logwood contains tannic acid, which is soluble in water, but boiling water extracts it from the wood better than cold water. No direction is given for powdering.

Extractum Quassiæ, N. F. The wood is exhausted with cold water, the percolate boiled to precipitate albuminous matter, and filtered. The yield is comparatively small, the extract being ten times as strong as the wood.

FIXED OILS

Fixed oils are oils which cannot be distilled without decomposition. In the so-called fats the proportion of stearin and palmitin is sufficient to solidify the olein, oils and fats consisting chiefly of the three compounds. These are compounds of glycerin with oleic, stearic, and palmitic acids. The elements present are carbon, hydrogen, and oxygen, any nitrogen or sulphur present being due to albumin or other foreign matter.

Properties. Oils, when pure, are nearly colorless, odorless, and tasteless. Many commercial oils are not pure, and have decided odors and tastes, and are often colored yellow to red, or they may be green from the presence of chlorophyl. They are greasy to the touch, not fluorescent, very slightly soluble in water, sparingly soluble in alcohol (except a few like castor or cocoanut), soluble in the immiscible solvents (ether, chloroform, benzol, etc.), expand on cooling, and not inflammable but burn with a wick. Superheated steam breaks them up into glycerin and free fat acids. Most vegetable oils are liquid, a few solid.

Fixed oils are divided into two classes—drying and non-drying. Drying oils thicken with the absorption of oxygen, and are finally converted into a mass or film. Diffused through porous matter, the oxidation may take place so fast that ignition results. They do not form elaidin, and do not readily become rancid. Some oils have properties of both drying and non-drying oils.

Non-drying oils become rancid with the liberation of free fat acids. The odor of rancid oils is due to butyric and other volatile acids. A rancid oil can often be restored by shaking with a dilute solution of an alkali and then washing with water. There is less liability to become rancid when large proportions of stearin and palmitin are present.

Purification. Oils may be purified in various ways. 1. Exposure to sunlight bleaches some. 2. Heating to 240° C. for ten minutes, or a lower temperature for a longer time. 3. Filtration through charcoal, kaolin, silica, or felt bags. 4. Washing with water. 5. Treatment with a small amount of concentrated sulphuric acid. 6. Treatment with alkalies. 7. Reducing agents. 8. Pressure. 9. Standing.

Tests for Identification. 1. Specific gravity. 2. Melting- or solidifying-point. The melting- and solidifying-points for a given fat often are not the same. 3. Viscosity or body. This test is made by determining the time it takes for a given weight or volume of oil at a given temperature to flow through a given aperture. 4. Color reactions. 5. Refractometer. 6. Absorption spectra. 7. Thermal test. The determination of the amount of heat produced by the action of sulphuric acid on the oil. 8. Reichert-Meissl determination of volatile fat acids. 9. Elaidin test. Determining whether an oil will become solid when treated with nitrous acid or not. 10. Iodine absorption test. U. S. P., page 590. 11. Saponification number. U. S. P., page 590.

VOLATILE OILS

Volatile, distilled, or essential oils are oils which can be distilled without decomposition. Most of them come from the plant kingdom, a few from the animal kingdom and a few are made synthetically. In some plants the oil exists in all parts, while generally it is found in special cells, glands, cavities, or canals. There may be two or more oils in the same plant. They are most commonly found in flowers, fruits, and leaves, less frequently in roots, seldom in seeds. They appear to be excretion products, and are useful in attracting insects which help fertilization of the plant. Many of the oils come from the countries around the Mediterranean Sea, although a few are distilled in the U. S.

Obtaining. The methods of obtaining the oils vary with the part of plant used and the nature of the oil. 1. Expression. This is used when the plant is soft and the amount of oil large, as in case of lemon or orange. 2. Simple distillation is used in a few cases, as oil of turpentine or copaiba. 3. Distillation with steam. The material is macerated with water and then distilled, or steam is forced through it. Water aids volatilization and prevents burning. In the distillate the oil is separated from the water, and may be exposed for a few days to air to dissipate a "still" odor. 4. Solution is used when the oil is present in small amounts and is easily decomposed. (*a*) Percolation with purified benzin or carbon disulphide. (*b*) Solution in a fixed oil, like purified cottonseed oil. (*c*) Spreading a layer of flowers on a layer of purified suet or petrolatum, letting them remain for twelve hours, then replacing with fresh flowers. 5. Fermentation, as volatile oil of mustard. 6. Synthesis, as oil of wintergreen.

Properties. Volatile oils when pure are colorless. Commercial oils may be yellow, green, blue, red, brown, or black, the color being due to oxidation products or impurities in solution. The odor in general resembles that of the plant from which it comes, but is not as fine. In many cases the odor is more characteristic when it is highly diluted. Strong oils paralyze the sense of smell. The taste is generally hot, pungent, or acrid. Oils are sparingly soluble in water, but sufficiently so to give odor and taste. They are quite soluble in alcohol and readily so in the immiscible solvents. Many are lighter than water, but some are heavier. The boiling-point is over 150° C., but varies with the proportion of its constituents. They have a strong refractive power. Volatile oils dropped on paper do not leave a stain that cannot be volatilized by heat, unless they have become resinified. They are neutral or slightly acid to litmus, not unctuous to touch, easily ignited, and burn with a smoky flame. Exposure to air and light destroys the fragrance.

Composition. Volatile oils are mixtures, often containing several hydrocarbons and oxygenated compounds. Of the hydrocarbons the terpenes are the most common; some of them are pinene, camphene, and limonene. Hydrocarbons are optically active, less soluble in alcohol or diluted alcohol than oxygenated compounds. Some of them in the presence of water oxidize with the formation of hydrogen dioxide, which may partly account for their antiseptic properties. Generally terpenes do not give the characteristic properties to the oil, but act as diluents.

Oxygenated compounds may belong to alcohols, aldehydes, acids, esters, ethers, or other classes. Some are formed by oxidation of hydrocarbons. They are more soluble in diluted alcohol or water than the terpenes, and may give a finer flavor than the oil. Linalool, linalyl acetate, geraniol, geranial, citronelol, citronelal, camphor, terpineol, vanillin, cumarin, eugenol, safrol, and cinnamic aldehyde, are some of the oxygenated compounds.

Identification. 1. Specific gravity is of but little service, as it varies for different samples of the same oil. 2. The boiling-point also varies for the same oil. 3. Iodine reacts violently with some, and may have no reaction with others. 4. Bromine and chlorine react with some. 5. Hydrochloric acid combines with some to make solid compounds. 6. Sulphuric acid thickens some, chars others, or gives color reactions. 7. Acid sulphites combine with aldehydes to make crystalline compounds. 8. Other agents are used to produce colors.

Adulterants. Cheaper volatile oils, fixed oils, and alcohol are the more common adulterants, and are often difficult to detect.

OLEORESINS

Oleoresins are mixtures of resins and volatile oils, frequently with small amounts of other substances. Some occur naturally as exudations and some are obtained by extraction. Copaiba is an example of the first class, and oleoresins of aspidium and capsicum are examples of the second. The U. S. P. directs all of the preparations under the class of oleoresins to be made by extracting the drug with ether, except in case of cubebs, where alcohol is used. Ether as a rule is a better solvent for oils and resins than alcohol, and does not take out as much other matter. Ether is very volatile, and evaporates at a lower temperature than acetone, which was used in the U. S. P. VIII. The Pharmacopœia directs oleoresins to be made in percolators, but they can be made in a continuous percolation apparatus as Soxhlet's tube or some modification of it, whereby the ether may be used over again. Oleoresins should be kept in well-stoppered bottles to prevent volatilization and oxidation of the oils.

COMMENTS

Oleoresina Aspidii. Oleoresin of male fern deposits a granular, crystalline matter, consisting chiefly of filicic acid, which is the active principle, and consequently should be stirred up before removing any of the oleoresin. Only fresh male fern should be used, and it yields about 15 per cent of oleoresin. It should have a green or greenish brown color.

Oleoresina Capsici. Oleoresin of red pepper deposits an inert fatty matter which should be separated and rejected. The U. S. P. directs percolation to a certain amount, not to exhaustion. The first part of the percolate contains the active matter and further percolation loads it with inert fatty matter.

Oleoresina Cubebæ. An inert waxy substance separates on standing, and should be rejected. As alcohol, which is the menstruum directed, has a higher boiling-point than ether, the preparation is best made by simple percolation.

Oleoresina Petroselini. An inert waxy matter separates, and should be rejected. This oleoresin is sometimes called liquid apiol.

Oleoresina Piperis. This has been prescribed under the name of oil of black pepper. Piperine separates from the oleoresin on standing, and the U. S. P. directs its removal. While piperine has some therapeutic action, it is different from that of the oil or resin.

Oleoresina Lupulini, N. F. Lupulin, which yields about 60 per cent of oleoresin, contains so much resinous matter that the first part of the solvent becomes very thick and viscid, and the drug should consequently be packed only very lightly.

RESINS

Resins may be obtained as exudations, by distilling off the oil from oleoresins, or by extraction with a solvent. Resins should not be confused with resinoids of the Eclectic School of Medicine, which are impure mixtures of active principles. Resins of jalap, mandrake, and scammony are made by percolating the drugs with alcohol, evaporating off the alcohol, and pouring the residue into water to precipitate the resin.

COMMENTS

Resina Jalapæ. The alcoholic extract is not concentrated as much as in making the other resins, and is poured into water at ordinary temperature, washed with hot water, and dried on a water-bath.

Resina Podophylli. In making the resin of mandrake the syrupy liquid left after distilling off the alcohol is poured into cold water to which hydrochloric acid has been added. The cold and the acid aid the precipitation of resin. The resin is washed with cold water and dried without heat. The product thus obtained is more brown, and less of the lemon-green color than the commercial resin. Manufacturers use other agents than hydrochloric acid, as alum, which gives a brighter but somewhat inferior product.

Resina Scammoniæ. Scammony root is used instead of the gum-resin as previously, the gum-resin varying greatly on account of adulteration. The syrupy liquid left after evaporating off the alcohol is poured into hot water, the precipitate washed with hot water, and dried with heat.

ALKALOIDS

Definitions. An alkaloid has been defined as "A nitrogenous, carbon compound, derived from the vegetable kingdom, and capable of neutralizing acids." A ptomain is also a nitrogenous carbon compound, capable of neutralizing acids, but is produced by bacteria working on animal or vegetable matter. A leucomain is a similar compound, but it occurs as the result of normal tissue changes in the living body.

Constitution. It was once thought that alkaloids were ammonium compounds in which ammonia existed as such, united to various radicals. It is now generally accepted that alkaloids contain amidogen (NH_2), or in other words that one hydrogen atom of ammonia is replaced by a radical which is different for each alkaloid. Many alkaloids are related to pyridin and chinolin, which are volatile bases found in bone oil. Some have been made synthetically from these bases. Alkaloids contain either three or four elements; some contain, C, H, and N, and others also contain O.

General Properties. In the plants alkaloids are naturally in combination with an acid as tannic, kinic, citric, malic, meconic, or sulphuric. Narcotine and hydrastine are said to exist in the free condition to some extent.

Alkaloids are divided into two classes—volatile and non-volatile.

Volatile alkaloids are few in number compared with the non-volatile ones. They are of little importance therapeutically. They contain C, H, and N, but no O. They are liquid at ordinary temperature, and can be volatilized without decomposition in steam or hydrogen. They are colorless when pure, but become brown or red on exposure. They are generally quite soluble in water, alcohol, ether, chloroform and other solvents, strongly basic, and form salts with acids, the salts generally being solid. Water solutions of salts are generally precipitated by alkaloidal reagents, except the alkalies.

Two hundred to three hundred non-volatile alkaloids have been described. They contain C, H, N, and O. Many of them are quite strongly alkaline to litmus, some weakly alkaline, and some neutral. The majority have no effect on phenolphthalein. With acids they form salts in which the acid is added on and the hydrogen of the acid is not replaced, the alkaloid acting like NH_3. Many of the non-volatile alkaloids are crystallizable, some amorphous. They are generally white, odorless, have a bitter or burning taste, and are active physiologically.

Free non-volatile alkaloids are usually sparingly soluble in water, but soluble in alcohol and the immiscible solvents, as ether, chloroform, benzol, etc. Salts of the alkaloids with mineral acids are generally soluble in water and alcohol, but sparingly soluble in the immiscible solvents. While there are many exceptions to these two statements, it is upon these principles that alkaloids are separated from organic matter in the assay processes.

Many non-volatile alkaloids are decomposed by high heat, and some by the heat of a water-bath. A few, like caffeine, can be sublimed. Light decomposes many alkaloids slowly, causing them to turn yellow.

General Alkaloidal Reagents. These are agents which generally precipitate alkaloids from water solutions of their salts. Some of them are alkalies, potassium mercuric iodide, iodine in a solution of potassium iodide, tannic acid, platinum chloride, and others. Practically everything that is alkaline will precipitate the alkaloid as the free alkaloid. The other reagents usually give a precipitate of the alkaloidal salt and reagent combined, and cause more complete precipitation if the solution is acid.

Identification. Alkaloids are most commonly identified by color reactions, although microscopical and physiological tests are sometimes used. Some of the agents used to produce colors are nitric acid, sulphuric acid, sulphuric acid with potassium dichromate, ammonium selenite in sulphuric acid, ammonium molybdate in sulphuric acid, formaldehyde in sulphuric acid, chlorine followed by ammonia, and many others.

Assay. Active principles of drugs are estimated by separating and weighing them, by separating and titrating them with acid and alkali, or by determining the degree of physiological action. The general method of separating alkaloids from the crude drugs is to add a mixture of ether and chloroform and then ammonia water. The ammonia liberates the free alkaloid from its salt, and it is then dissolved by the ether-chloroform. To purify the alkaloids, the ether-chloroform solution is treated with acidulated water; the acid converts the alkaloids into salts which are soluble in water but not in the ether-chloroform. The acid water solution is made alkaline with ammonia and chloroform is added to dissolve the free alkaloids; the chloroform solution is separated and the solvent evaporated. The residue is dried and weighed, or a definite amount of standard acid added and the excess titrated back with a standard alkali.

MAGMAS

Magmas are bulky precipitates which hold a large amount of water. They are difficult to wash free from impurities, and are better washed by decantation than by filtration.

COMMENTS

Magma Bismuthi, *Milk of Bismuth.* Bismuth subnitrate is converted into the normal nitrate and also dissolved by the nitric acid in water. This solution diluted with acidulated water is poured into a solution of ammonia with a little ammonium carbonate. The precipitate is a mixture of bismuth hydroxide and a little bismuth subcarbonate. The hydroxide must not be allowed to get dry or some oxide is formed. The formulas for bismuth subnitrate used and subcarbonate formed vary, but the following equations approximately represent the reactions:

$$\underset{\substack{\text{Bismuth}\\ \text{subnitrate}}}{BiONO_3} + \underset{\substack{\text{Nitric}\\ \text{acid}}}{2HNO_3} = \underset{\substack{\text{Bismuth}\\ \text{nitrate}}}{Bi(NO_3)_3} + \underset{\text{Water}}{H_2O}.$$

$$\underset{\substack{\text{Bismuth}\\ \text{nitrate}}}{Bi(NO_3)_3} + \underset{\substack{\text{Ammonium}\\ \text{hydroxide}}}{3NH_4OH} = \underset{\substack{\text{Bismuth}\\ \text{hydroxide}}}{Bi(OH)_3} + \underset{\substack{\text{Ammonium}\\ \text{nitrate}}}{3NH_4NO_3}.$$

$$\underset{\substack{\text{Bismuth}\\ \text{nitrate}}}{2Bi(NO_3)_3} + \underset{\text{Ammonium carbonate}}{2NH_4HCO_3 \cdot NH_4NH_2CO_2} + \underset{\text{Water}}{H_2O}$$
$$= \underset{\substack{\text{Bismuth}\\ \text{subcarbonate}}}{(BiO)_2CO_3} + \underset{\substack{\text{Ammonium}\\ \text{nitrate}}}{6NH_4NO_3} + \underset{\substack{\text{Carbon}\\ \text{dioxide}}}{3CO_2}.$$

Magma Magnesiæ. Milk of magnesia is magnesium hydroxide suspended in water. It readily absorbs carbon dioxide from the air, and hence the containers must be well stoppered. Magnesium hydroxide is alkaline and slightly soluble in water. It cannot be washed until the wash water does not affect phenolphthalein, but it must be washed until a certain amount of water with a given amount of acid is not alkaline. When this is accomplished it shows that practically all the sodium carbonate and the excess of hydroxide used is washed out. The amount of water first used should be increased as there is not sufficient to decant. Magnesium carbonate is a mixture of hydroxide and carbonate $(MgCO_3)_4Mg(OH)_2$, being approximately the formula.

$$(MgCO_3)_4Mg(OH)_2 + 8NaOH = 5Mg(OH)_2 + 4Na_2CO_3.$$

Magma Ferri Hydroxidi, N. F. In order to prevent the formation and precipitation of basic ferric sulphate the solutions of iron and of ammonia are diluted. For the same reason cold water is used, and the iron poured into the ammonia, the latter always being in excess. If the ammonia were poured into the iron solution, the iron would be in excess at first and the basic salt would be precipitated. The ferric hydroxide is so bulky that it is difficult to wash on the filter, and also if it gets dry some oxide is formed. This hydroxide is used in making some other iron preparations, and as an antidote for arsenic poisoning.

$$Fe_2(SO_4)_3+6NH_4OH=2Fe(OH)_3+3(NH_4)_2SO_4.$$

Charta Potassii Nitratis, *Potassium Nitrate Paper*, N. F. In using this paper it is burned, and the fumes inhaled. It burns without a flame. The nitrate is decomposed to some extent, being reduced by the organic matter of the paper.

Chloralum Camphoratum, *Camphorated Chloral*, N. F. Rubbing camphor and hydrated chloral together in the cold, or heating them together, produces a liquid compound which is decomposed by water.

Gargarisma Guaiaci Compositum, *Compound Gargle of Guaiac*, N. F. If honey were not used, the large amount of resinous matter in tincture of guaiac which is precipitated by water would make masses and stick to the bottle. Honey while not preventing the precipitation does prevent the formation of masses, and helps to suspend it as a powder.

Menthol Camphoratum, *Camphorated Menthol*, N. F. Menthol and camphor form a liquid when rubbed or heated together. There is probably a reaction which might not take place by dissolving them separately in alcohol.

CHEMICALS

Acidum Hydriodicum Dilutum. Two reactions take place.

$$\underset{\text{Potassium iodide}}{KI} + \underset{\text{Tartaric acid}}{H_2C_4H_4O_6} = \underset{\text{Hydriodic acid}}{HI} + \underset{\text{Potassium acid tartrate}}{KHC_4H_4O_6}.$$

$$\underset{\text{Potassium hypophosphite}}{KPH_2O_2} + \underset{\text{Tartaric acid}}{H_2C_4H_4O_6} = \underset{\text{Hypophosphorous acid}}{HPH_2O_2} + \underset{\text{Potassium bitartrate}}{KHC_4H_4O_6}.$$

Cream of tartar is nearly all precipitated, and dilute alcohol is used to make the precipitation more complete. Hydriodic acid is easily oxidized by the air, liberating iodine. Hypophosphorous acid is required to prevent this oxidation. If the acid becomes colored from free iodine, some hypophosphorous acid should be added.

Acidum Nitrohydrochloricum. On mixing nitric and hydrochloric acids, a yellow to a red solution is formed and considerable gas is given off. There seems to be a difference of opinion as to the compounds formed. The U. S. P. says it is a solution of nitric acid, hydrochloric acid, nitrosyl chloride, and chlorine, but does not state whether it is the mono- or the di-nitrosyl. The following equations are given to show the probable reactions:

$$\underset{\text{Nitric acid}}{HNO_3} + \underset{\text{Hydrochloric acid}}{3HCl} = \underset{\text{Nitrosyl monochloride}}{NOCl} + \underset{\text{Chlorine}}{2Cl} + \underset{\text{Water}}{2H_2O}.$$

$$\underset{\text{Nitric acid}}{HNO_3} + \underset{\text{Hydrochloric acid}}{3HCl} = \underset{\text{Nitrosyl dichloride}}{NOCl_2} + \underset{\text{Chlorine}}{Cl} + \underset{\text{Water}}{2H_2O}.$$

$$\underset{\text{Nitric acid}}{2HNO_3} + \underset{\text{Hydrochloric acid}}{6HCl} = \underset{\text{Nitric oxide}}{2NO} + \underset{\text{Chlorine}}{6Cl} + \underset{\text{Water}}{4H_2O}.$$

Acidum Nitrohydrochloricum Dilutum. The strong acids are mixed and then diluted. It is a disputed question whether this product is the same as that produced by diluting the acids, then mixing and allowing to stand for several days. Made in either way, the solution is colorless and does not have much odor of chlorine. The dilute acid is approximately one-fourth as strong as the concentrated nitrohydrochloric acid.

Acidum Sulphuricum Aromaticum, *Elixir of Vitriol.* This acid is colorless at first, but after several weeks it becomes reddish, due to the action of the acid on the oil and tincture. Some reaction takes place between the acid and alcohol, forming ethyl sulphate and ether.

Argenti Nitras Fusus, *Molded Silver Nitrate, Lunar Caustic.* The hydrochloric acid forms a little silver chloride which makes the pencils tougher and less brittle.

Caffeina Citrata. The name indicates that this is a mixture and not a chemical compound. Citrate of caffeine can be made, but it is broken up into caffeine and citric acid when treated with water.

Ferri Carbonas Saccharatus, *Saccharated Carbonate of Iron.* The reaction is similar to that in making mass of carbonate of iron, except that sodium bicarbonate is used in place of the normal carbonate. The reason for this variation is not plain, as the products formed are the same, the bicarbonate giving off more carbon dioxide. Sugar helps to prevent oxidation, but the preparation should be kept in small well-stoppered bottles.

Ferri Hydroxidum cum Magnesii Oxido, *Arsenic Antidote.* To be effective as an antidote for arsenic poisoning, ferric hydroxide must be fresh. Exposed to air and light, the hydroxide changes to the oxide, which does not combine with arsenic as readily. For this reason the solution of iron and the magnesium hydroxide (formed by the oxide and water), are kept separate until wanted, but are ready for mixing and immediate administration.

$$\underset{\substack{\text{Magnesium}\\\text{oxide}}}{MgO} + \underset{\text{Water}}{H_2O} = \underset{\substack{\text{Magnesium}\\\text{hydroxide}}}{Mg(OH)_2}$$

$$\underset{\substack{\text{Ferric}\\\text{sulphate}}}{Fe_2(SO_4)_3} + \underset{\substack{\text{Magnesium}\\\text{hydroxide}}}{3Mg(OH)_2} = \underset{\substack{\text{Ferric}\\\text{hydroxide}}}{2Fe(OH)_3} + \underset{\substack{\text{Magnesium}\\\text{sulphate}}}{3MgSO_4}.$$

Sulphur Lotum. Sublimed sulphur frequently contains a little sulphuric acid and sulphide of arsenic. With the acid, ammonia makes ammonium sulphate, which is more easily washed out than the free acid. With arsenous sulphide, ammonia makes ammonium arsenite and sulpharsenite, which are soluble in water. Sulphur should be protected from air, as it slowly oxidizes.

$$\underset{\substack{\text{Sulphuric}\\\text{acid}}}{H_2SO_4} + \underset{\substack{\text{Ammonium}\\\text{hydroxide}}}{2NH_4OH} = \underset{\substack{\text{Ammonium}\\\text{sulphate}}}{(NH_4)_2SO_4} + \underset{\text{Water}}{2H_2O}.$$

$$\underset{\substack{\text{Arsenous}\\\text{sulphide}}}{As_2S_3} + \underset{\substack{\text{Ammonium}\\\text{hydroxide}}}{6NH_4OH} = \underset{\substack{\text{Ammonium}\\\text{arsenite}}}{(NH_4)_3AsO_3} + \underset{\substack{\text{Ammonium}\\\text{sulpharsenite}}}{(NH_4)_3AsS_3} + \underset{\text{Water}}{3H_2O}.$$

Sulphur Præcipitatum, *Milk of Sulphur.* Precipitated sulphur is purer and in a finer powder than sublimed sulphur. Boiling milk of lime with sulphur gives calcium thiosulphate and various sulphides, which give a brownish-red solution. Any sulphide of arsenic is changed to the arsenite and sulpharsenite, which are soluble. Hydrochloric acid is not added in sufficient amount to neutralize the solution, because if it were the arsenic would be reprecipitated, and also sulphur from the thiosulphate. Sulphur precipitated from the thiosulphate is coarser and less soluble in carbon disulphide. Sulphuric acid should not be substituted for hydrochloric, because it makes calcium sulphate, which is precipitated with sulphur.

$$\underset{\text{Lime}}{CaO} + \underset{\text{Water}}{H_2O} = \underset{\substack{\text{Calcium}\\\text{hydroxide}}}{Ca(OH)_2}.$$

$$\underset{\substack{\text{Calcium}\\\text{hydroxide}}}{3Ca(OH)_2} + \underset{\text{Sulphur}}{6S} = \underset{\substack{\text{Calcium}\\\text{disulphide}}}{2CaS_2} + \underset{\substack{\text{Calcium}\\\text{thiosulphate}}}{CaS_2O_3} + \underset{\text{Water}}{3H_2O}.$$

$$\underset{\substack{\text{Calcium}\\\text{hydroxide}}}{3Ca(OH)_2} + \underset{\text{Sulphur}}{12S} = \underset{\substack{\text{Calcium}\\\text{pentasulphide}}}{2CaS_5} + \underset{\substack{\text{Calcium}\\\text{thiosulphate}}}{CaS_2O_3} + \underset{\text{Water}}{3H_2O}.$$

$$\underset{\substack{\text{Arsenous}\\\text{sulphide}}}{2As_2S_3} + \underset{\substack{\text{Calcium}\\\text{hydroxide}}}{6Ca(OH)_2} = \underset{\substack{\text{Calcium}\\\text{arsenite}}}{Ca_3(AsO_3)_2} + \underset{\substack{\text{Calcium}\\\text{sulpharsenite}}}{Ca_3(AsS_3)_2} + \underset{\text{Water}}{6H_2O}.$$

$$\underset{\substack{\text{Calcium}\\\text{pentasul-}\\\text{phide}}}{CaS_5} + \underset{\substack{\text{Hydro-}\\\text{chloric}\\\text{acid}}}{2HCl} = \underset{\substack{\text{Calcium}\\\text{chloride}}}{CaCl_2} + \underset{\text{Sulphur}}{4S} + \underset{\substack{\text{Hydrogen}\\\text{sulphide}}}{H_2S}.$$

Potassa cum Calce, *Vienna Paste,* N. F. Both ingredients absorb water and carbon dioxide from the air, and consequently should be protected. Heating the mortar tends to prevent the absorption. An iron mortar is preferable because the alkali does not attack iron as it does silica in a porcelain or Wedgwood mortar. The above comments hold true for the N. F. Soda with Lime (London paste).

Sulphuris Iodidum, N. F. Sulphur and iodine combine to form an unstable compound which liberates iodine on exposure to air.

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